Midwest Environmental Advocates

MEA Review of Health Impact Assessment of Industrial Sand Mining In Western Wisconsin

The industrial sand mining industry has grown dramatically in recent years in response to demand for sand used in the hydraulic fracturing process for oil and gas extraction. Citizen concern has also grown as facilities have expanded in number, size and production rate. Midwest Environmental Advocates (MEA) works with these citizens to ensure clean air, water, land, and government for this generation and the next.

A public health institute, Institute for Wisconsin's Health, Inc., recently released a *Health Impact Assessment of Industrial Sand Mining in Western Wisconsin* (HIA).[1] This HIA was intended for use by local and tribal health departments "in decision-maker discussions about the potential health effects of existing and proposed industrial sand facilities."[2] Citizens and local government officials have contacted MEA with questions about whether the HIA adequately assesses the potential health impacts of the industrial sand mining industry based on existing evidence. Regarding certain impacts, there are concerns that the HIA does not acknowledge that there is not enough evidence to dismiss potential health impacts. MEA's analysis of the HIA is based on our years of experience working on environmental issues associated with industrial sand mining as well as consultation with experts and agency staff in various fields.

The *Minimum Elements and Practice Standards for Health Impact Assessment* provide the framework to ensure only robust HIAs are used to inform decisions that may impact public health. Several standards in particular influenced MEA's analysis. Those preparing the HIA "should acknowledge where evidence is insufficient to evaluate or judge health effects identified as priority issues in the

[1] Attachment A, (Boerner, A., Young, N., & Young, D., Institute for Wisconsin's Health, Inc. *Health Impact Assessment of Industrial Sand Mining in Western Wisconsin* (2016)).
[2] Attachment A, HIA at 7.

screening and scoping stage of HIA."[3] In our view, it is critically important to protect the public from emerging public health threats by reserving judgment until there is adequate evidence to reach a conclusion. Further, "The HIA reporting process should offer stakeholders and decision-makers a meaningful opportunity to critically review evidence, methods, findings, conclusions, and recommendations. The HIA practitioners should address substantive criticisms."[4]

Guided by those principles, MEA prepared this review of the HIA. This is intended to serve as a resource for citizens and decision-makers who would like to use the HIA to inform their actions.

1. **Does not explicitly acknowledge potential health threats that were not analyzed or impacts where evidence insufficient to reach a conclusion**

Our main concern with the HIA is its failure to analyze and reach a conclusion about potential impacts that present a significant threat to public health. Specifically, the HIA fails to reach any conclusion about the risk of air quality impacts from fine particulate matter—PM2.5—and water quality impacts from heavy metal leaching.[5] It is common for an HIA to limit its scope to certain impacts, but typically the HIA will explicitly acknowledge the limited scope or impacts not assessed.[6]

As to these potential impacts, the appropriate conclusion may be that there is insufficient evidence to determine how likely it is that negative health effects will occur.[7] But it is critical to acknowledge data gaps and unknowns. Instead, the HIA makes reference to these public health threats, but fails to draw any conclusions or make any recommendations about how decision makers should respond.

Air Impacts from PM2.5: The HIA notes that PM2.5 particles are generally more hazardous to human health than other particle sizes.[8] The analysis mentions a published study of PM2.5 emissions from industrial sand mines in western Wisconsin, but concludes that that study did not contribute to an understanding of the issue."[9] Instead, the HIA barely addresses PM2.5 other than noting that data from regional PM2.5 ambient air monitors shows "PM2.5 concentrations have been generally decreasing since 2008, and all Wisconsin counties are currently in compliance with

---

[3] Bhatia R., Farhang L., Heller J., Lee M., Orenstein M., Richardson, M., Wernham, A. (2014, September). *Minimum Elements and Practice Standards for Health Impact Assessment*, 4.3.6 (3rd ed.), available at http://hiasociety.org/?p=547.

[4] *Id.* at 6.5.

[5] Attachment A, HIA at 39-42,

[6] *See, e.g.*, Roxana Z. Witter et al., *The Use of Health Impact Assessment for a Community Undergoing Natural Gas Development*, available at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3698738/.

[7] Attachment A, HIA at 21 (noting that the HIA may characterize the likelihood and intensity of potential health effects by noting where there is insufficient evidence).

[8] Attachment A, HIA at 30.

[9] Attachment A, HIA at 34.

the daily and annual PM2.5 air quality standards."[10] These regional monitors are not designed to measure the impact that a particular industry or facility has on air quality. The HIA air quality section then reaches conclusions about the potential health impacts of PM10 and respirable crystalline silica, but does not assess the potential risk of health impacts from PM2.5.

For several years, MEA has raised concerns that the Wisconsin Department of Natural Resources (DNR) does not adequately limit PM2.5 emissions from industrial sand facilities, including in recent comments on a proposed air permit.[11] *The HIA's failure to analyze the health risks of PM2.5 or to discuss the lack of data about PM2.5 emissions from this industry undermines the HIA's air quality analysis.*

Water Quality Impacts from Heavy Metal Leaching: The HIA water resources section focuses on the impact of water-soluble polymer use at industrial sand facilities because that was the most common water quality concern raised during the scoping process.[12] While that may have been the primary concern raised by stakeholders, that does not mean that heavy metal leaching from the industrial sand mining process does not present a potential public health concern. DNR and MEA have publicly raised the concern that industrial sand wastewater and stormwater may contain metals that could enter surface waters and groundwater. As briefly noted in the HIA, DNR and the Wisconsin Geological and Natural History Survey are evaluating the risk of heavy metal discharges to groundwater from process wastewater used at industrial sand mines.[13] *The HIA water resources section should have explicitly raised this potential, serious risk to water resources and explained that there is currently not enough evidence to dismiss the potential health threat posed by heavy metals in industrial sand wastewater.*

2. Relies on evidence without adequate discussion of its limitations

Air quality impact of crystalline silica: The HIA's analysis of potential health impacts from crystalline silica relies primarily on one industry-funded study conducted at facilities all owned by the same company, EOG Resources.[14] This study, which we will call the Richards study, analyzed data from ambient air monitors to determine the concentration of crystalline silica around EOG Resources' industrial sand facilities. Because the HIA, DNR, and the industrial sand industry have put so much emphasis on this study, MEA hired an environmental consultant with expertise in air pollution

[10] Attachment A, HIA at 31.
[11] Attachment B (MEA comment on DNR's proposal to issue an air permit to Superior Silica Sands, noting that industrial sand facilities do emit PM2.5, and raising concerns about DNR's regulation of this pollutant).
[12] Attachment A, HIA at 49.
[13] Attachment A, HIA at 51; *see also* Wisconsin Public Radio, *DNR To Study If Frac Sand Mining Contaminates Groundwater* (Apr. 12, 2016), available at http://www.wpr.org/dnr-study-if-frac-sand-mining-contaminates-groundwater.
[14] Richards, J., & Brozell, T. (2015). Assessment of community exposure to ambient respirable crystalline silica near frac sand processing facilities. *Atmosphere, 6*, 960-982.

monitoring and modeling studies to review the Richards study.[15] This review explains some limitations of the Richards study, which should be kept in mind when the results are relied upon in an analysis of industrial sand facilities' impact on air quality.

The review of the Richards study revealed that the air monitors were not placed in the location of maximum facility impacts given prevailing wind directions. This means that the air monitors likely did not sample where we would expect to find the greatest impact from the facilities. Additionally, the Richards study used a data analysis process that is approved only for air monitoring in occupational settings, and that is not approved by EPA or DNR for this type of ambient air monitoring study. This is significant because the HIA air quality analysis provides that the research team gave more weight to data collected in accordance with EPA-approved monitoring methods.[16]

Another expert in this field, epidemiologist and public health expert Kirstie Danielson, Ph.D., prepared her own comments on the HIA and also raised concerns about its reliance on these industry-funded studies.[17] Industry-funded studies or studies involving voluntary participation by the industry under scrutiny may provide useful data, but should be subject to heightened scrutiny. There is no avoiding the fact that the regulated industry has an incentive to show that it does not have negative environmental impacts. The data adds to the body of evidence about potential health impacts of the industrial sand industry, but should not be relied upon too heavily to dismiss the potential risk of impacts. *Given the limitations on the Richards study and the HIA reliance on it, MEA questions the HIA's conclusion that the evidence is "very strong" that potential health impacts from respirable crystalline silica are "unlikely."*[18]

Human health outcomes: Epidemiologist Dr. Kirstie Danielson criticized the HIA's use of county-level health statistics and asthma rates to dismiss impacts where in her professional opinion there is not yet enough data to draw conclusions about the link between industrial sand mining and human health outcomes.[19] Dr. Danielson questioned the HIA authors' methods in analyzing the data and concluded that the data cited did not support the HIA's conclusions. She concluded, "*As we have learned from almost a century of research on environmental health and chronic disease, it can take several years to decades for many of the diseases of interest to develop, therefore data from a time frame of a few years cannot be used to draw valid conclusions.*"[20]

---

[15] Attachment C (James Fleischmann comments on Richards study monitoring protocol).
[16] Attachment A, HIA at 34 (noting that "datasets collected in accordance with ambient air sampling operating standards (which are set by the U.S. EPA and supported in the published literature) were more heavily weighted when determining the potential risks to human health from particulate matter").
[17] Attachment D.
[18] Attachment A, HIA at 40.
[19] Attachment D.
[20] Attachment D.

3. Minimizes or fails to include relevant evidence

The HIA notes that university researchers recently published a study of community-level PM2.5 ambient air monitoring, but concludes that "the research team did not find the study contributed to understanding of the issue" because of "deviations from approved air monitoring standards and the partial nature of the dataset."[21] One of the authors of the PM2.5 study, Dr. Crispin Pierce, responded to the HIA's failure to report the results of the PM2.5 study in response to a request by MEA:

> By not reporting our peer-reviewed and published data, the HIA authors have excluded the only published data on PM2.5 (fine particulate) levels around frac sand facilities. These PM2.5 particulates are more strongly associated with cardiovascular disease, lung disease and lung cancer than the PM10 particulate values supplied by industrial sand facility operators included in the HIA.
>
> While the reason stated for not including the PM2.5 data is that the instrument used (the SKC deployable particulate sampler [DPS]) is not a federal reference method-designated instrument, the DPS accuracy relative to other samplers (i.e., MiniVol [Airmetrics, Inc.], and FH 62 C14 continuous ambient PM monitor [Thermo Andersen]) has been established.

The PM2.5 study certainly has limitations, which the authors acknowledge, just as the Richards study has limitations as described above. Like the Richards study, it provides evidence relevant to a discussion of the air quality impact of industrial sand facilities. Epidemiologist Dr. Kirstie Danielson also raised questions about the HIA's reliance on monitoring voluntarily conducted by industry in contrast to the HIA's dismissal of the publicly-funded PM2.5 study authored by university researchers.[22] Given the limited available data regarding industrial sand facilities' PM2.5 emissions, and the serious potential health impacts, it seems inappropriate to exclude the results of this peer-reviewed, published PM2.5 study that raises concerns about PM2.5 emissions.

We note that the HIA also cites to, but does not discuss or analyze, PM2.5 sampling reported by the Minnesota Pollution Control Agency (MPCA).[23] The MPCA data provides additional information about this industry's PM2.5 emissions that could have been discussed and analyzed along with studies such as the one conducted by Dr. Pierce's team. *Because the HIA does not include any of this PM2.5 data, the air quality analysis should explicitly state that it does not assess or draw conclusions about the public health impact of PM2.5 emissions from industrial sand facilities.*

[21] Attachment A, HIA at 34.
[22] Attachment D.
[23] Attachment A, HIA at 43-44.

4. Does not evaluate the effectiveness of the regulatory framework

An HIA needs to have a limited scope that is adequate for the purpose it was prepared, taking into account limitations on the time, resources, and expertise of the entity preparing it. While it is appropriate for HIA authors to limit the scope of the analysis, it must include enough information to accomplish the purpose for which it was prepared. This HIA excludes from its scope an analysis of the state's regulation of air and water quality.

In the air pollution section, a text box provides, "Fugitive dust plans are required by the Wisconsin Department of Natural Resources to manage the potential for dust to escape off-site."[24] In response to MEA's concerns about the DNR's regulation of air pollution, IWHI responded that evaluating fugitive dust plans is outside the scope of the HIA. In the water resources section, the HIA provides that DNR's regulation of surface water discharges "are generally outside the scope of this HIA," and directs readers to the 2012 DNR report Silica Sand Mining in Wisconsin.[25]

Excluding an analysis of the adequacy of DNR's regulation calls into question some of the HIA's conclusions. For example, the HIA notes that fugitive dust plans manage the potential for off-site emissions, but the IWH states it did not evaluate whether these plans are effective. *This disconnect creates the perception that IWH relies on these regulations to support its conclusion that air quality impacts are unlikely, without making clear that the scope of the HIA did not include an analysis of the regulatory framework.*

MEA believes that any analysis of the environmental and public health impacts of this industry must weigh whether regulations, as written and implemented, are working as intended. This is particularly important because Wisconsin residents and the media have raised concerns over the DNR's ability to regulate this industry as it has grown in recent years.[26]

5. Does not include balanced stakeholder involvement or public input

It is common for the HIA process to include an opportunity for public comment and input, though certainly not required.[27] An opportunity for public comment would have been particularly important

---

[24] Attachment A, HIA at 32.

[25] Attachment A, HIA at 47; citing DNR, *Silica Sand Mining in Wisconsin* (Jan. 2012), available at http://dnr.wi.gov/topic/Mines/documents/SilicaSandMiningFinal.pdf.

[26] *See e.g.*, Rich Kremer, *DNR Reworks Frac Sand Mining Permits*, Wisconsin Public Radio (Apr. 11, 2016), available at http://www.wpr.org/dnr-reworks-frac-sand-mining-permits; Steven Verberg, *As DNR woes grow, former critic says she's its best protector*, Wisconsin State Journal (June 26, 2016), available at http://lacrossetribune.com/news/local/state-and-regional/as-dnr-woes-grow-former-critic-says-she-s-its/article_e96f5709-16f6-54ea-a430-8dfd14097a64.html.

[27] North American HIA Practice Standards Working Group, *Practice Standards for Health Impact Assessment*, Version 1, at 4, 6-7 April 7, 2009, available at www.sfphes.org (noting the importance of public participation and input during the scoping, assessment, and reporting stages of the HIA process).

for this HIA given the level of public interest on this issue. *Citizens, environmental and public health organizations that have been working on this issue for years would have provided additional information for the HIA authors to consider, and in our view, would have resulted in a more balanced and useful HIA.*

HEALTH IMPACT ASSESSMENT

OF INDUSTRIAL SAND MINING IN WESTERN WISCONSIN

ATTACHMENT A

Cover photo: Dan Young

Suggested Citation: Institute for Wisconsin's Health, Inc. (2016). *Health Impact Assessment of Industrial Sand Mining in Western Wisconsin*. Madison, WI: Boerner, A., Young, N., & Young, D.

Support: This project was supported by a grant from the Health Impact Project, a collaboration of the Robert Wood Johnson Foundation and The Pew Charitable Trusts. The views expressed are those of the authors and do not necessarily reflect the views of the Health Impact Project, The Pew Charitable Trusts or the Robert Wood Johnson Foundation.

Contact: Nancy Young, Executive Director of Institute for Wisconsin's Health Inc., for more information: nyoung@instituteforwihealth.org.

INSTITUTE FOR WISCONSIN'S HEALTH INC.
749 University Row, Suite 110
Madison, Wisconsin 53705
Website: www.instituteforwihealth.org

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

The Institute for Wisconsin's Health gratefully recognizes advisors, project partners, and community members who provided direction and input on this Health Impact Assessment. We are extremely grateful for the expertise and guidance provided by our technical assistance providers, Amber Lenhart, Marla Orenstein and Erica Westwood.

Those who provided data and technical expertise on various facets of industrial sand mining include:

Badger Mining Corporation
Cecilia Kraus
David Greendeer
Fairmount Santrol
Holly Dolliver
Ian Anderson, Wisconsin Department of Natural Resources
Jason Treutel, Wisconsin Department of Natural Resources
Penny Ybarra
Robert Mann
Roberta Walls, Wisconsin Department of Natural Resources
Smart Sand
Western Wisconsin Regional Planning Commission
Wisconsin Division of Public Health, Wisconsin Environmental Public Health Tracking
Wisconsin Geological and Natural History Survey
Wisconsin Industrial Sand Association

The following individuals provided subject area expertise and comments on one or more assessment topics:

Dan Masterpole, Chippewa County Land Conservation & Forest Management (Land Reclamation and Water Resources)
Jay Zambito, Wisconsin Geological and Natural History Survey (Water Resources)
Jim Aiken, Barr Engineering (Water Resources)
John Richards, Air Control Techniques, P.C. (Air Quality)
Lauren Evans, Fairmount Santrol (All)
Mark Krumenacher, GZA GeoEnvironmental, Inc. (All)
Mike Parsen, Wisconsin Geological and Natural History Survey (Water Resources)
Peter Thorne, University of Iowa Environmental Health Sciences Research Center (Air Quality and Water Resources)
Ron Kosheshek (Quality of Life)
Seth Ebel, Chippewa County Land Conservation & Forest Management (Land Reclamation and Water Resources)
Sheila Ugargol Keefe, Barr Engineering (All)
Todd Lindblad, SmartSand (All)
Wisconsin Department of Natural Resources (WDNR data & regulations)
Wisconsin Industrial Sand Association (All)

TECHNICAL ASSISTANCE

Amber Lenhart, Health Impact Project
Marla Orenstein, Habitat Health Impact Consulting
Erica Westwood, Habitat Health Impact Consulting

HIA RESEARCH TEAM

Institute for Wisconsin's Health:	Audrey Boerner, MS – HIA Specialist, report author Tom Sieger, MS – Special Project Advisor and IWHI Board President Nancy Young, MPA – Executive Director Dustin Young, BA, CQIA – Manager Muriel Nagle, MPH – Early contributor to the project

HIA ADVISORS AND PROJECT PARTNERS

Jeff French	Barron County Health and Human Services Department
Kelli Engen	Barron County Health and Human Services Department
Nicole Hunger	Buffalo County Dept. of Health and Human Services
Jennifer Rombalski	Chippewa County Department of Public Health
Robert Leischow	Clark County Health Department
Wendy MacDougall	Dunn County Health Department
Thomas Aarrestad	Dunn County Health Department
Cortney Draxler	Eau Claire City/County Health Department
Lieske Giese	Eau Claire City/County Health Department
Shane Sanderson	Eau Claire City/County Health Department
Carol Rollins	Ho-Chunk Nation Department of Health
Kevin Gunderson	Ho-Chunk Nation Department of Health
Christine Hovell	Jackson County Dept. of Health and Human Services
Sarah Spah	La Crosse County Health Department
Jim Steinhoff	La Crosse County Health Department
Sharon Nelson	Monroe County Health Department
Heidi Stewart	Pepin County Health Department
Michele Williams	Pierce County Public Health Department
Sue Galoff	Pierce County Public Health Department
Anita Zimmer	Rusk County Dept. of Health and Human Services
Deb Lindeman	Saint Croix County Dept. of Health and Human Services
Patricia Malone	Trempealeau County - UW Extension
Cheryl Rhoda	Trempealeau County Health Department
Nancy Wyland	University of Iowa - College of Public Health
Peter Thorne	University of Iowa - College of Public Health
Tim Ringhand	Wisconsin Western Region Division of Public Health

EXECUTIVE SUMMARY

This health impact assessment (HIA) was performed by the Institute for Wisconsin's Health in collaboration with 15 local and tribal health departments in western Wisconsin. The impetus for the assessment was the recent rapid growth of industrial sand mining in western Wisconsin, and related concern from community members about potential environmental and health impacts of industrial sand mining. Four focus areas were selected for further study during the scoping process of this HIA: air quality, water resources, land reclamation and value, and quality of life.

There has been industrial sand mining in Wisconsin for over 100 years. However, the number of industrial sand mines has dramatically increased over the past 10 years. "Industrial sand" includes sand mined for industrial uses as diverse as glass, foundry, water treatment, and hydraulic fracturing. Hydraulic fracturing, commonly called fracking, is a process used by the energy industry to maximize the recovery of oil and gas from deep rock formations. When industrial sand is injected into rock, it props open fractures and allows oil and gas to flow into the well. In 2014, Wisconsin was the nation's largest supplier of industrial sand for oil and gas drilling, providing nearly 44% of the sand used in the United States. Wisconsin sand is desirable for its strength, uniformity, and ability to be shipped by rail to regions where fracking occurs.

The audience for this report is primarily local and tribal health departments, though other interested stakeholders will find the assessment and recommendations relevant. We recommend that this HIA be used in decision-maker discussions about the potential health effects of existing and proposed industrial sand facilities.

This assessment examines the potential positive and negative health impacts of various aspects related to existing and potential future industrial sand facilities in the context of western Wisconsin. Based on this structure, the reader should note that some potential impacts will be specific to the site and community of an existing or proposed facility.

What is Health Impact Assessment?

Health impact assessment is an unbiased and scientific assessment of the potential positive and negative health effects of a proposed project, program or policy. HIAs are used to inform decision makers of the potential health implications, and provide recommendations to maximize positive health benefits, and reduce negative health outcomes.

SYNTHESIS OF FINDINGS

This HIA found that the potential exists for both positive and negative health effects from industrial sand mining. For purposes of this report we have characterized the likelihood of potential positive or negative health effects on a spectrum from "insufficient evidence" to "very likely" See page 20-21 of the full report for more information.

AIR QUALITY

Health effects from the impact of industrial sand mining on community-level air quality related to PM10[i] are unlikely. In addition, it is unlikely that community members will be exposed to respirable crystalline silica from industrial sand mining as currently regulated; therefore, health effects from exposure are unlikely. Data collected at several facilities in the upper Midwest do not indicate that health-based standards have been exceeded in regard to these potential pollutants.

[i] Particulate matter with an aerodynamic diameter below 10 µm. This size range is generally able to travel into the upper airway and is regulated by national air quality standards.

Why conduct an HIA on sand mining?

The rapid development of the industrial sand industry in Wisconsin and other upper-Midwestern states has generated a number of questions by community members and policy makers regarding potential health risks or benefits to the community. Concerns raised range from environmental topics to changes in local economics and lifestyle. Differing opinions on risks, benefits, and community values have led to divisions within and among many communities regarding whether industrial sand mining should continue in western Wisconsin.

WATER RESOURCES

The potential for health effects from impacts to *groundwater quantity* is possible. Industrial sand mining facilities that withdraw groundwater have the potential to impact surrounding wells and surface water features. However, these impacts are highly site specific and localized. If health effects do occur, the most common effects are expected to be related to stress or anxiety experienced by a limited number of individuals.

Health effects from contaminant impacts to *groundwater quality* are unlikely. In the event that water-soluble polymers are released into groundwater, impurities are expected to readily degrade and would be significantly diluted before they could come in contact with drinking water users near industrial sand sites.

LAND RECLAMATION AND VALUE

Health effects (positive or negative) from reclamation of industrial sand mines are unlikely. No community-level health effects from reclaimed industrial sand mines in Wisconsin have been identified, and reclamation plans implemented in accordance with NR 135 are likely to prevent health hazards at a mine site.

Health effects from impacts to land value from an industrial sand facility are possible. The potential for health effects is highly site specific and depends on a range of factors. The most likely negative health effects due to impacts to land value are feelings of stress for landowners who want to sell their property, especially if they experience difficulty selling it. Impacts to land value are expected to be localized, and not community-wide.

QUALITY OF LIFE

Health effects from the impact of industrial sand mining on cultural heritage or sense of place are likely. This finding does not imply that these effects will be widespread, but *some* individuals are likely to experience health effects.

Economic impacts from industrial sand mining are likely. Impacts may be positive or negative and will be highly dependent on the community, facility, and individual. The direction of economic impacts may change over time.

Health effects from traffic, light, and noise are possible, though they will be highly dependent on the proximity of residents to industrial sand facilities, facility design, and other factors. If health effects do occur, the most common effects are expected to be stress or annoyance from traffic or nuisance levels of light and noise.

RECOMMENDATIONS

This assessment holds two overarching recommendations for proposed or existing industrial sand facilities:

1. Development of industry standards that help to promote thoughtful review, policy, and project development, as well as positive relationships with community members, and,

2. Representation from local, tribal, or regional public health departments as part of the local permitting or review process.

Focus area-specific recommendations were also developed in consultation with community and industry partners. Those recommendations are found in the full report.

SECTION 1. INTRODUCTION

This health impact assessment examines the potential health impacts (both positive and negative) of industrial sand mining in western Wisconsin. The World Health Organization defines Health Impact Assessment (HIA) as "A combination of procedures, methods, and tools by which a policy, program, or project may be judged in terms of its potential effects on the health of a population and the distribution of those effects within the population."[1] HIAs are conducted to inform decisions about policies, programs, or projects by analyzing the potential health benefits or risks associated with the decisions. After analyzing health data and input from stakeholders, HIA research teams develop recommendations that decision makers can use to make decisions. The intent of the HIA process is that decision makers will use the findings to reduce (or eliminate) the negative impacts on health and maximize positive health impacts.

The primary audience for this HIA is leadership from local and tribal health departments in western Wisconsin. These governmental public health departments are charged with promoting and protecting health in communities in a nonpartisan manner, and on a daily basis they work with a broad array of community stakeholders. The results of this HIA will also be useful to communities outside of western Wisconsin in which industrial sand mines currently operate or may operate in the future.

This HIA discusses four focus areas that relate to potential health impacts from industrial sand mining at the community level: air quality, water resources, land reclamation and value, and quality of life. It is outside the scope of this report to provide an in-depth explanation of industrial sand mining processes, environmental impacts, and applicable regulations in Wisconsin. Interested readers should refer to the 2016 Wisconsin Department of Natural Resources Strategic Analysis (in progress at the time of publication of this HIA) for these additional.

The Institute for Wisconsin's Health, Inc. (IWHI) prepared this assessment with technical assistance from Habitat Health Impact Consulting and the Health Impact Project. This HIA was undertaken to inform pending decisions in four communities in western Wisconsin: Eau Claire County, Pierce County, Trempealeau County, and the Ho-Chunk Nation. Health department leadership in each of these communities served as principal advisors for the assessment process. These health departments had a vested interest in protecting the health of the public, a desire for more information on industrial sand mining, and a day-to-day working relationship with stakeholder groups.

In order to provide the most relevant findings and recommendations in the local context, this HIA modified the traditional HIA approach in two ways:

1) Rather than assessing the potential health impacts of a single proposed project, this HIA assesses the industrial sand mining industry in a region.

Industrial sand mining was already occurring in or near each of these communities prior to the inception of this HIA. This report can be used to inform pending or future decisions regarding industrial sand mining in western Wisconsin communities.

2) By focusing on the industry of sand mining, this HIA covers the large geographical region of 14 counties and the Ho-Chunk Nation, which operates its own tribal health department.

These modifications precluded the ability of this research team to conduct site-specific analyses of any single industrial sand facility. However, similarities between facilities within the industry and between communities near sand mines do allow for thorough and scientific review and understanding of potential health impacts of industrial sand mining in Wisconsin. Potential health impacts may be experienced differently among communities in the study area. As a result, potential health impacts indicated in this report should be understood in the context of local conditions.

CONTEXT

Industrial sand mining has been occurring in Wisconsin for over 100 years; however, the number of industrial sand mines in the state has dramatically increased over the past 10 years. As of September 1, 2015, there were 85 active industrial sand facilities in Wisconsin.[2] "Industrial sand" includes sand mined for industrial uses as diverse as glass, foundry, water treatment, the oil and gas industry, and other applications. Sand is used by oil and gas developers to increase the amount of the resource that can be recovered from a single well through hydraulic fracturing, or "fracking".[3] Fracking involves injecting, at very high pressure, sand and fluids into deep rock layers. When the sand is injected into the rock, it props open fractures in the rock and allows oil and gas to flow out of the rock and into the well. One term for sand used for this application is "frac sand". In the last 15 years, horizontal drilling technology (as opposed to traditional, vertical drilling) has allowed for the development of additional oil and natural gas resources that were not previously economically viable. This specific development has contributed to the industrial sand "boom" over the last 10 years in Wisconsin and other parts of the country.

Because "frac sand" describes only a subset of the sand mined in Wisconsin, this report will instead use the term "industrial sand" in reference to the industry. In 2014, Wisconsin was the nation's largest supplier of industrial sand for oil and gas drilling, providing nearly 44% of the sand used in the US—more than the tonnage supplied by Illinois, Minnesota, and Texas combined (the three leading producers behind Wisconsin).[4]

Industrial sand mines in western Wisconsin are typically developed in areas where layers of sandstone are near the surface (Fig. 1.1). These sandstone units are ideal for industrial sand because of the uniform composition (mostly silica [quartz] sand), roundness, size, and high crush-strength. This strength keeps the rock fractures open deep underground. In many of Wisconsin, sandstone lies near the surface and breaks apart easily, both of which contribute to relatively low excavation and processing costs. In addition, a well-developed rail network in Wisconsin minimizes shipping costs for sand producers. Sand mined specifically for hydraulic fracturing is commonly shipped by rail to oil-producing areas such as North Dakota, Pennsylvania, Texas, and others.

Generally, industrial sand mining and processing is a relatively simple process compared to metallic mining operations. Low-energy blasting is sometimes required to break apart the sandstone units. Sand is then excavated and lightly worked to separate grains, washed to remove fines (silt or clay), and sorted to separate grains that are too large or too small. Wet sand may be dried immediately or stockpiled for drying later. Dry sand is then stored onsite and eventually shipped by rail or truck to the consumer.

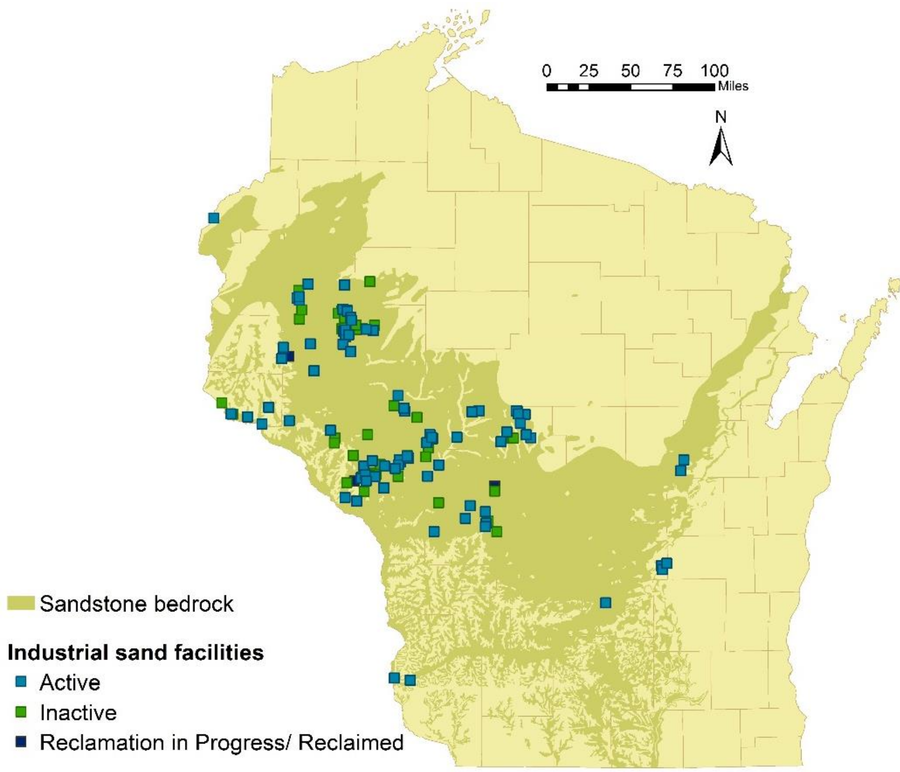


Figure 1.1. Industrial sand mines and processing facilities as of September 2015. Sandstone bedrock extent represents the rock type generally targeted for industrial sand mining. Sources: Wisconsin Department of Natural Resources and Wisconsin Geological and Natural History.

RELEVANCE

The rapid development of the industrial sand industry in Wisconsin and other upper-Midwestern states has generated a number of questions by community members and policy makers regarding potential health risks or benefits to the community. Concerns raised range from environmental topics to changes in local economics and lifestyle. Differing opinions on risks, benefits, and community values have led to divisions within and among many communities regarding whether industrial sand mining should continue in western Wisconsin. Industrial sand mining opponents often cite several reasons to increase regulations for, or ban, industrial sand mining, including landscape change, economic instability, and potential harm to air quality and water resources. Some community members simply oppose the practices of hydraulic fracturing and mining nonrenewable resources. Those in favor of industrial sand mining have stated that potential benefits outweigh potential risks, that the creation of jobs and economic diversity will be a positive outcome for many communities, and that environmental impacts can be mitigated by proper management and regulatory oversight.

The 14-county study area for this HIA is shown in Figure 1.2. The Ho-Chunk Nation was also engaged in this study; Ho-Chunk Tribal lands are spread throughout Wisconsin and Minnesota. This large area was selected because industrial sand mining activities in this area have increased significantly in recent years and the health departments here have expressed a strong interest in an HIA.

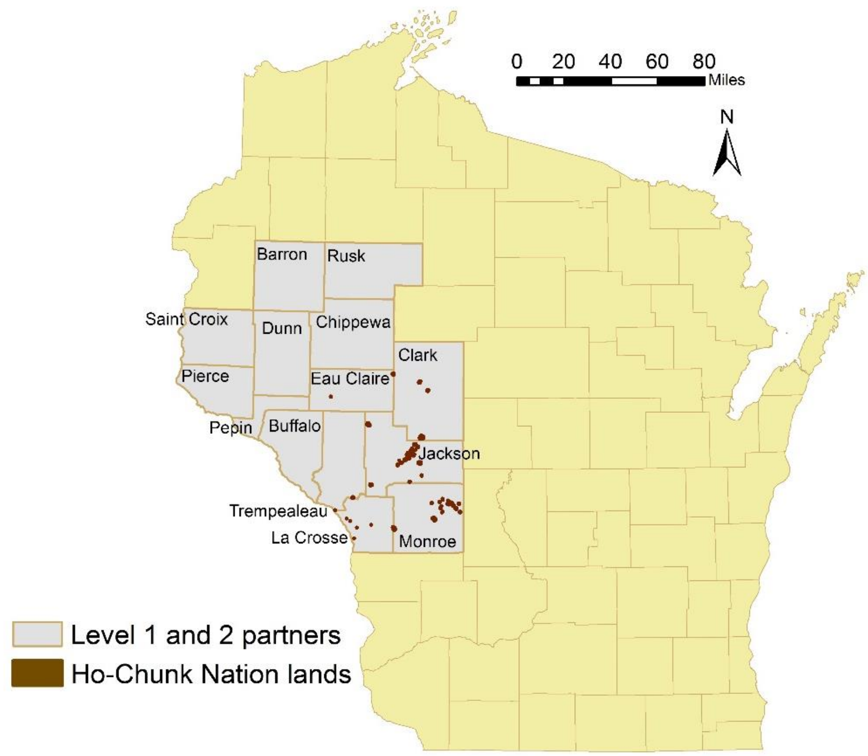


Figure 1.2 The highlighted area indicates the geographic scope of this HIA. The HIA advisory committee consists of representatives of the 14 local health departments, Western Region Division of Public Health, Ho-Chunk Nation Department of Health (located in Jackson County), and University of Iowa Environmental Health Sciences Research Center. On this map, the scale of Ho-Chunk lands is increased for visibility.

[1] World Health Organization European Centre for Health Policy. (1999). *Health impact assessment: main concepts and suggested approach*. Brussels: WHO Regional Office for Europe
[2] Wisconsin Department of Natural Resources. (2015, September 8). *Locations of industrial sand mines and processing plants in Wisconsin.* Retrieved from http://dnr.wi.gov/topic/Mines/ISMMap.html.
[3] Suchy, D.R., & Newell, D. (2011, December). *Hydraulic fracturing of oil and gas wells in Kansas.* Kansas Geological Survey Public Information Circular 32.
[4] Bleiwas, D. (2015, May 26). *Estimates of hydraulic fracturing (frac) sand production, consumption, and reserves in the United States.* Retrieved from http://www.rockproducts.com/frac-sand/14403-estimates-of-hydraulic-fracturing-frac-sand-production-consumption-and-reserves-in-the-united-states.html#.Vp-UObH2bIU

SECTION 2. METHODS

The standard steps for health impact assessment (HIA) are screening, scoping, assessment, recommendations, reporting, and monitoring and evaluation. Each of these steps is summarized in this section.

SCREENING

The purpose of screening is to identify whether an HIA will be useful and feasible.

In early 2014, the Institute for Wisconsin's Health became aware of some of the public health assessment and communications challenges associated with industrial sand mining in western Wisconsin. IWHI staff and consultants connect frequently with local and tribal health department leaders across the state because of ongoing work related to accreditation preparation, quality and performance improvement, strategic planning, and community health assessment and planning. It was through these "circles" that awareness began.

For many years, the IWHI board of directors and management had been interested in building HIA capacity. When IWHI learned of an HIA funding opportunity from the Health Impact Project, a collaboration of the Robert Wood Johnson Foundation and The Pew Charitable Trusts, it seemed that IWHI's leadership, the industrial sand mining issue, and the Health Impact Project's interests might be a good match. IWHI requested a place on the agenda of the Wisconsin Association of Health Departments and Boards (WALDHAB) Western Region meeting on June 4, 2014 to explore this idea further. WALDHAB is a statewide organization of health department and board of health leaders that is divided into regional groups to enable regular discussion and action around public health. IWHI also engaged the University of Iowa's Environmental Health Sciences Research Center (UIEHSRC) and the Wisconsin Division of Public Health (WDPH) Western Region Office because of their involvement with air quality monitoring and public health protection, respectively.

INITIAL SCREENING EFFORTS

In the summer of 2014, IWHI's executive director approached local and tribal health department leaders in western Wisconsin to gauge interest in, usefulness of, and feasibility of a health impact assessment of industrial sand mining. This discussion began with an exploratory meeting with WALDHAB in June 2014, at which the group discussed the potential opportunity afforded by the call for proposals, the call's parameters, and HIA in general. The WALHDAB group was asked directly if an HIA using a regional approach would provide any value to the communities that the leaders represented. The potential funding opportunity was also candidly presented, including resource limits, the fact that it was unlikely that new environmental testing could be funded by such an effort, and that for a proposal to be competitive, there needed to be not just an interest in the issue, but "live" or at least impending policy decisions under consideration in one or more communities. Attendees at this meeting expressed enthusiasm for proposal development and confidence in IWHI as an independent, unbiased primary applicant. It became clear that while the majority of the region's health departments (15 of 20), as well as many other organizations, were engaged in the topic, there was no unifying approach to data collection, analysis, or communication for the communities sharing these common interests and challenges. There was also a strong desire to gain capacity in the science of HIA through a project such as this, so that it could be applied to future issues.

DETERMINATION OF LEVEL 1 AND LEVEL 2 PARTNERS

Local and tribal health departments in Wisconsin are charged with protecting and promoting health within their jurisdictions. The departments are non-partisan entities accustomed to weighing evidence and communicating risk and benefit on a variety of issues to the public. We selected health departments as project partners because they expressed a strong interest in industrial sand mining and because of their day-to-day knowledge of (and access to) the appropriate stakeholder groups. Simply put, in our view, health departments are the *ideal touchstone* for all matters relating to potential public health risks and benefits.

The concept of Level 1 and Level 2 project partnership was developed based on the following:

- Level 1 partners are those local and tribal health departments who are currently or imminently considering a policy decision related to industrial sand mining.
- Level 2 partners are those local and tribal health departments who are not currently or imminently considering a policy decision, but who have sand mining in or very near their jurisdictions and may be making policy decisions in the future.

We asked each of the 20 local or tribal health departments that are members of the Western Region WALDHAB group to indicate if they were interested in becoming a Level 1 or Level 2 partner. We made it clear that there was no implication that the issue of sand mining was more important to Level 1 than to Level 2 partners. We also emphasized that our intent was to involve organizations that had varying views in the assessment and to carry out an assessment that was non-partisan and as bias-free as possible. Fourteen local health departments and one tribal health department expressed an interest in being project partners. Eau Claire County, Peirce County, Trempealeau County, and the Ho-Chunk Nation identified policy decisions related to industrial sand mining that were time sensitive. These communities also indicated that they were interested in becoming Level 1 partners for this study. The other counties expressed a strong interest in the assessment to inform future policies, programs, or practices and elected to be Level 2 partners. A complete list of partner communities and representatives is provided on page 6.

WHAT DECISIONS WILL BE INFORMED BY THE HIA?

1) At the time the HIA proposal was being developed, three townships in Eau Claire County were actively engaged in policy discussions influenced in part by silica mining: Bridge Creek had no current zoning, was in very early conversations related to silica mining, and was considering development of a comprehensive plan. Lincoln was considering developing a comprehensive plan to replace the current land use plan, and Otter Creek was considering

revisiting a 2009 comprehensive plan. The Town of Lincoln passed a comprehensive plan in August 2015. At the time of writing this report, the decisions for Bridge Creek and Otter Creek are still "in play."

2) In fall 2014, the Pierce County Land Management Department began to re-examine the county's conditional use permitting practices regarding inclusion of air monitoring requirements at sand processing plants. These discussions continue, and this HIA is likely to be used as a tool for making a decision on the county's conditional permits for industrial sand mines.

3) When our proposal was developed, Trempealeau County, with 10 operating mines and an additional 18 permitted, had a moratorium on development of new mines in place. It was due to expire on August 31, 2014 and was not extended. The County Environmental and Land Use Committee has been frequently reviewing the impacts of sand mining at committee meetings, with potential for recommending policy change(s) at any time. A moratorium in the city of Arcadia, Trempealeau County, was in place until September 2015 and was not renewed. There continues to be great interest from a variety of stakeholders in the county, and the recommendations of this HIA will likely be factored into policy, program, and practice development in the near future.

4) The Ho-Chunk Nation currently has a resolution prohibiting industrial sand mining on Ho-Chunk Nation lands. This resolution may be revised at any time following completion of the HIA report. In addition, the Nation is beginning to build an air quality monitoring program, in part based on Tribal member concerns related to airborne silica, and the HIA will inform the scope and development of that program. The President of the Ho-Chunk Nation has expressed support of the HIA project; the engagement of the President of a sovereign nation underscores the importance of this issue to the Tribe, the region, and potentially to other Native American communities in the US.

At the end of the screening process, the HIA research team believed that decisions related to Tribal lands and culture, permitting, moratoria, and comprehensive planning in the four communities requesting Level 1 partnership were both important and broadly representative for the region. Further, we believed that the HIA could have implications for other industrial sand mining communities in the US.

SCOPING

The purpose of scoping is to set the parameters for what health effects the HIA will examine and what assessment approach will be used.

To initiate the scoping process and to help focus project resources on the issues of greatest importance, the HIA team engaged the representatives of stakeholder groups in each community in a survey. We sent the online survey to stakeholders who had been identified by Level I partners. Persons invited to participate represented the Wisconsin Industrial Sand Association, local government, university faculty, advocacy groups, and Ho-Chunk Tribal members. Survey results were analyzed to determine broad topics of interest to stakeholder groups within the Level 1 partner communities. We then shared the top-rated concerns with local and Tribal health department leadership in both Level 1 and Level 2 communities, and those leaders commented on and confirmed the topics of highest relevance.

Next, the HIA team, in consultation with Level 1 and 2 partners, prioritized which health determinants and health impacts to evaluate, and then developed research questions that directly related to the prioritized health determinants (Table 2.1). Research questions were developed for each of the four topic areas that are the focus of this HIA: **air quality, water resources, land reclamation and value, and quality of life.** Again, Level 1 and Level 2 partners offered comments and insight into research questions that would be most helpful for informing pending or future decisions in their communities. We used this feedback to finalize the research questions for this HIA.

Table 2.1 Health determinants and related research questions determined during scoping.

Health Determinant	Explanation	Central Research Question
Air Quality		
Air quality	There are many different environmental factors that can impact health. Air quality can directly impact physical well-being, management of chronic conditions, the onset of illness, and lifespan.	How will industrial sand mining potentially impact air quality?
Water Resources		
Water quality and quantity	Water quality and quantity can directly impact physical well-being, management of chronic conditions, the onset of illness, and lifespan.	How will industrial sand mining potentially impact water quality and quantity?
Land Reclamation and Value		
Soil and water quality	Land reclamation restores disturbed areas to other beneficial land uses. Reclamation serves to protect the next land user from health hazards, such as impacts to water quality, soil quality, and physical hazards from the previous land use.	How will reclamation impact health?
Investment value and Income	Potential threats to an individual's property value can lead to stress, anxiety, and resulting physical health outcomes. Property owners may also realize a loss to their property value due to an undesirable adjacent land use.	How will industrial sand mining impact property value?

Health Determinant	Explanation	Central Research Question
Quality of Life		
Economic & job opportunities	The impacts of employment on health have the potential to be profound and may range from mental and physical health to chronic disease prevalence and life span. Employment also provides income stability and therefore can be directly related to the ability to obtain necessities for healthy living such as food, safe housing, and health care.	How will industrial sand mining potentially impact community economics?
Social cohesion & support	The social cohesion and support determinant examines the health impacts of relationships with and support from other community members and an individual's surroundings. The determinant is measured by evaluating the health impacts of stress and disturbance to individual sense of place. Poor social cohesion or support can impact individual physical, emotional, and mental well-being by increasing stress, isolation, or other factors.	How will industrial sand mining potentially impact individual sense of place?
Culture	Cultural heritage, including family or community heritage, refers to the behavioral norms or patterns that support an individual's ability to identify with a group. Though this determinant is related to social support, it is more accurate to consider it separately. Cultural heritage can explain health inequities differently than other social determinants, though cultural inequities in health can often be attributed to underlying inequalities in social health determinants.[1]	How will industrial sand mining potentially impact cultural heritage?
Environmental aesthetics	Environmental aesthetics in this study include the presence of excessive light, noise, and traffic. These factors can impact physical and mental well-being through disruption of routine activities (sleep, recreation, relaxation), negative impact on public safety, or change in how individuals relate to their environment.	How will industrial sand mining potentially impact physical surroundings?

Table 2.1 (cont.) Health determinants and related research questions determined during scoping.

COMMUNITY HEALTH PROFILE

The community health profile compiled for this assessment (Section 3) provides a summary of the current health status of the four Level 1 partner communities, including measures that are representative of the population's general health and those that specifically relate to potential impacts of industrial sand mining. Key data sources for the community health profile were obtained through Wisconsin's Health Hub on Community Commons, the West Central Wisconsin Regional Planning Commission, and the 2013 Ho-Chunk Nation Community Health Assessment.

ASSESSMENT

The purpose of the assessment is to identify whether impacts are likely to occur and then to quantify or characterize the predicted impacts.

The assessment phase of this HIA consisted of four steps:

1) Develop a baseline community health profile for the four Level I partner communities, including general demographic data and health measures related to the four topic areas.
2) Identify the general practices used in industrial sand mining in Wisconsin, including general processes, distribution, applicable regulations, and the relationships between industry and local authorities. Also, identify data (collected by state or private entities) that is related to potential health or environmental impacts of industrial sand mining.
3) Identify the ways in which industrial sand mining practices have the potential to affect the health of local communities.
4) Characterize the effects on potential health pathways.

INDUSTRIAL SAND MINING PRACTICES

In order to best understand and accurately investigate potential health impacts of industrial sand mining, staff dedicated time to better understanding the range of sand mining practices in western Wisconsin. This investigation included:

- tours of above ground and underground industrial sand mines,
- personal communication with mine operators and representatives of the Wisconsin Industrial Sand Association as well as Department of Natural Resources staff who oversee sand mine permitting and data collection,
- review of the 2012 Wisconsin DNR report *Silica Sand Mining in Wisconsin* and other white papers,
- phone and in-person informant interviews with other researchers of potential environmental impacts of industrial sand mining in Wisconsin, and
- key informant interviews with Ho-Chunk Nation members who reside within the geographic scope of this HIA.

Existing conditions for each of the four focus areas are summarized in assessment sections 4-7.

CHARACTERIZING HEALTH EFFECTS

Effect characterization is a way to communicate the potential health impacts of industrial sand mining based on the findings of this HIA. It draws on the existing conditions, literature review, and perspectives of key informants regarding potential health pathways. This characterization provides a judgment of the overall likelihood, intensity (magnitude), quality of evidence, and distribution of potential health effects.

The following definitions are used in this assessment to characterize potential health effects:

Likelihood: How likely is it that a given health effect will occur in association with industrial sand mining

Insufficient evidence – The likelihood of a health effect cannot be judged based on available evidence

Unlikely – It is not likely that health effects will occur

Possible – Health effects are plausible

Likely – Health effects are probable

Very Likely – Health effects are highly probable

Intensity: The magnitude of the potential positive or negative health effects associated with industrial sand mining

Insufficient evidence – Evidence is inadequate to judge the intensity of health effects

Low – There are likely to be no or minimal health effects

Medium – Health effects may be minor; negative effects would be non-disabling

High – Positive or negative health effects may be considerable

Distribution: The expected impact based on proximity to an industrial sand facility

Occupational – Health effects, if any, may be limited to employees of the facility

Adjacent – Health effects, if any, may be experienced by individuals very near to a facility

Surrounding – Health effects, if any, may be experienced by individuals in the same community as a facility

Regional – Health effects, if any, may be experienced by individuals in western Wisconsin

Quality of evidence for the likelihood of health effects

None – There is no available evidence

Weak – Evidence is primarily anecdotal, based on media stories or individual reports

Moderate – Evidence is based on expert opinion, reports from experts, academics, industry, government, and others

Strong – Evidence is based on published studies not specific to western Wisconsin

Very Strong – Evidence is based on published studies specific to western Wisconsin

RECOMMENDATIONS

Recommendations are specific action items that describe how conditions should be amended in order to maximize health benefits and minimize negative health impacts.

Recommendations are based directly on the findings for potential health impacts and also consider feasibility of implementation. Before being finalized, the recommendations were first drafted by the HIA research team and then reviewed by Level 1 partners, Level 2 partners, and stakeholder group representatives.

This HIA offers:

1) **Recommendations**, which are suggested actions or policies that are likely to improve positive health impacts and minimize negative health effects.
2) **Considerations**, which address suggested actions that may improve health effects in some cases, but may not be relevant for all policy decisions.

REPORTING AND DISSEMINATION

Reporting and dissemination is the step in which HIA findings are compiled and communicated to decision makers, stakeholders, media, and the general public.

The reporting and dissemination stage includes sharing the HIA with all project partners, stakeholder group representatives, the Wisconsin Western Region Department of Public Health, Wisconsin DNR staff, mine operators, other decision makers in the western region, and the public. As needed, or upon request, we will plan additional dissemination of the findings by formal reporting or presentation.

MONITORING AND EVALUATION

The purpose of monitoring and evaluation is to track the effect of the HIA over time and to review the overall HIA process

The evaluation of this HIA will consider both process evaluation and impact evaluation. Process evaluation assesses the effectiveness of how the HIA was conducted and will answer the following questions:

1) Did the HIA process meet the *Minimum Elements and Practice Standards for Health Impact Assessment*? [2]
2) How could the process be improved to increase effectiveness and overall success?

Impact evaluation will assess the degree to which project objectives were achieved and the impact that this HIA had on stakeholders and decision makers. Monitoring and impact evaluation will occur continually for two years after the release of this report and will answer these questions:

1) Did project stakeholders find the process useful?
2) How was this HIA used to inform decisions that were pending upon the completion of this HIA?
3) Was this HIA used to inform policy decisions or practices that arose following the completion of this HIA?

The evaluation approach taken in this project will employ mixed methods, in which both qualitative and quantitative measures will be examined. We created the evaluation plan in consultation with Level 1 and Level 2 partners while the project was being organized. For each desired project outcome, we identified the corresponding activities, process indicators, and outcome measures before the start of the project. The HIA team presented initial ideas for measuring the outcome objectives to project partners and asked, "How will we know if this project accomplishes these outcomes?" and "Have we missed any measures that you believe are important to track?" Any measures that we considered feasible (given resource levels and timeline) were incorporated in the final evaluation plan.

---

[1] National Advisory Committee on Health and Disability. (1998*). The Social, Cultural, and Economic Determinants of Health in New Zealand: Action to Improve Health*. Wellington, New Zealand. Retrieved from https://nhc.health.govt.nz/system/files/documents/publications/det-health.pdf

[2] Bhatia R., Farhang L., Heller J., Lee M., Orenstein M., Richardson, M., & Wernham, A. (2014, September). *Minimum Elements and Practice Standards for Health Impact Assessment* (3rd ed.).

SECTION 3: COMMUNITY HEALTH PROFILE

This section profiles existing community health status among the four Level 1 partners in this study: Eau Claire County, Pierce County, Trempealeau County, and the Ho-Chunk Nation. The Level 2 Partners in western Wisconsin have broadly similar demographic characteristics to Level 1 partners, but addressing the health status of all partner communities in this report would not be feasible, given the resource limits of this HIA.

Describing the health status of populations in the vicinity of industrial sand mines is an important part of this HIA for two primary reasons. It broadly identifies what health challenges are currently being experienced, in order to examine whether these challenges may be affected by the presence of industrial sand mining. It also identifies potentially vulnerable population groups that may experience health inequities as a result of proposed or existing activities.

Key Facts

Level 1 Partner Ho-Chunk Nation

- Ho-Chunk Nation is not reservation-based; therefore, members do not reside in a single geographic area.
- Average income and high school graduation rates are less than the state average.

DEMOGRAPHIC CHARACTERISTICS

Table 3.1. Demographic characteristics of Level 1 Partner counties compared to statewide demographics

	Eau Claire County	Pierce County	Trempealeau County	Wisconsin
Population	99,788	40,870	29,098	5,706,871
Under 18 years of age	21%	22%	24%	23%
Over 65 years of age	13%	11%	16%	14%
Race/Ethnicity				
White	93%	97%	95%	87%
Black	0.8%	0.6%	0.4%	6%
Asian	3%	1%	0.4%	2%
Native American or Alaska Native	0.4%	0.5%	0.1%	0.9%
Hispanic	2%	2%	6%	6%

Source: Community Commons, http://www.communitycommons.org, 8/12/2015

The Level 1 partner counties, Eau Claire, Pierce, and Trempealeau, are primarily rural. The largest regional population center is Eau Claire, located in Eau Claire County, with a population of 67,545.

The Ho-Chunk Nation is also a Level 1 partner community, but Tribal members do not reside in a single geographic area. Community health data for the Ho-Chunk Nation is not available for all the measures reported for the county partners. Data about the

Ho-Chunk population is shared here with permission and is from the 2012 Ho-Chunk Community Health Profile, 2013 Ho-Chunk Nation Community Health Assessment, and the 2013 community health survey.

Table 3.2. Demographic characteristics for enrolled Ho-Chunk population within the 14-county geographic scope.

	Ho-Chunk Nation
Total Enrollment	2,278
Under 18 years of age	30%
Age 59+	12%

Source: Ho-Chunk Nation Heritage Preservation Office

SOCIAL AND ECONOMIC CHARACTERISTICS

SELECTED DEMOGRAPHICS

Key Facts
Level 1 Partner Counties

- Primarily rural
- Populations 93-97% white
- Unemployment lower than the state average
- Median per capita income slightly lower than the state average

The connection between socio-economic factors and health is well established. Specifically, income and education are two social determinants that can have substantial impacts on health. In areas where there is a high concentration of population living in poverty and without a high school education, health inequities may be greater. Other potentially vulnerable populations include children, elderly, and rural populations.

As of June 2015, unemployment in the Level 1 partner counties was relatively low and slightly below the state unemployment rate. Shaded cells in Table 3.3 indicate the greatest discrepancies between county and state averages. These differences may be due to a variety of factors.

Eighty-three percent of the respondents to the Ho-Chunk Nation 2013 community assessment survey indicated an average annual household income below the state average. Educational attainment data compiled by the Great Lakes Inter-Tribal Epidemiology Center for the Ho-Chunk Nation Contract Health Service Delivery Area, is included in Table 3.3.

Table 3.3. Socio-economic characteristics of Level 1 Partner communities.

	Eau Claire County	Pierce County	Trempealeau County	Ho-Chunk Nation†	Wisconsin
Median income per capita	$25,286	$27,462	$25,017	Not available	$27,522
Lack of social or emotional support	16%	15%	22%	Not available	16%
Associate's degree or higher (age 25+)	43%	37%	28%	13%‡	36%
No high school diploma	7%	7%	13%	16%	10%
Unemployment	5%	5%	5%	Not available	6%
Poverty (< 200% federal poverty line)	35%	27%	30%	Not available	31%
Food Insecurity*	13%	10%	10%	Not available	13%
Income inequality (rank among WI counties)**	4.6 (#70 of 72)	4.0 (#36 of 72)	3.8 (#14 of 72)	Not available	4.3

Source: Community Commons, http://www.communitycommons.org, 8/12/2015

†Data from Community Health Profile for 2012 developed by the Great Lakes InterTribal Epidemiology Center. Represents American Indian/Alaska Natives in Ho-Chunk Community Health Service Delivery Area. This area includes 15 Wisconsin counties and one Minnesota county extending beyond the geographic scope of this HIA.

‡Associates degree attainment data not available. Shows percentage with bachelor's degree or higher.

*Food insecurity is the household-level economic and social condition of limited or uncertain access to adequate food

**Ratio of household income at the 80th percentile to income at the 20th percentile; Source: County Health Rankings (2015)

ECONOMIC DIVERSIFICATION

Table 3. 4. Employment characteristics of Level 1 Partner communities.

	Eau Claire County	Pierce County	Trempealeau County
Top 3 employers (percent of all jobs)	Health Care (19%) Government (13%) Retail Trade (12%)	Government (30%) Manufacturing (12%) Accommodation/ Food Services (11%)	Manufacturing (40%) Government (14%) Health Care (7%)
Jobs in mining, quarrying, or oil & gas extraction	< 10 (less than .02%)	77 (0.6%)	78 (0.5%)

Source: West Central Wisconsin Regional Planning Commission, 2015 2nd Quarter Quarterly Census of Employment and Wages

Of the Level 1 Partner counties, Eau Claire County is the most economically diversified, with the largest employment sector providing less than one-fifth of all jobs in the county. Trempealeau County is the least economically diversified, with two-fifths of all jobs in the manufacturing sector.

CLINICAL CARE & HEALTH OUTCOMES

Level 1 Partner Counties - Health outcomes in the study area vary among the communities and compared to Wisconsin averages. Adults in Eau Claire and Trempealeau counties self-report asthma diagnosed by a health professional at a rate much higher than Pierce County or the Wisconsin averages. Trempealeau County also has the highest premature death rate in the study area, though it is slightly below the statewide average.

Tan cells in Table 3.5 highlight the greatest discrepancies (positive or negative) between county and state averages. These differences may be due to a variety of factors and may or may not be statistically significant. Generally, Trempealeau County has the most areas of concern, as it exceeds state averages in the percentage of adults self-reporting with asthma, in the percentage of the population reporting poor or fair health, in motor vehicle collision mortality, and in suicide rates. Eau Claire County has a higher population density and number of health care providers than the other partner communities, leading to a higher number of primary care physicians.

Level 1 Partner Ho-Chunk Nation - Among American Indian/Alaska Natives within the Ho-Chunk Community Health Service Delivery Area (most of Wisconsin, excluding 11 southeastern counties), heart disease and cancer were the two leading single causes of death. It should be noted that there are members from other tribes residing in this data catchment area as well. Approximately 23% of survey respondents in the 2013 Ho-Chunk Nation Community Health Assessment reported fair or poor health – higher than the self-reported rates in the three partner counties. The Ho-Chunk Nation has an active environmental health program and is initiating its own air quality monitoring program as this assessment nears completion.

	Eau Claire County	Pierce County	Trempealeau County	Wisconsin
% Adults with asthma	18%	9%	17%	11%
% Population reporting poor or fair general health	11%	11%	16%	12%
Premature deaths per 100,000 population	236	232	300	310
Cancer mortality per 100,000 population	162	167	166	174
Motor vehicle collision mortality per 100,000 population	9	14	20	10
Suicide deaths per 100,000 population	12	12	17	13
Primary care physicians per 100,000 population	129	47	31	82

Source: Community Commons, http://www.communitycommons.org, 8/12/2015

Table 3.5. Selected clinical care and health outcomes of Level 1 Partner counties.

Community Health Profile Highlights

Level 1 Partner Counties

- Are better than the state average in a range (though not all) of health outcomes
- Are regarded as having scenic and desirable physical environment
- Generally exhibit good air quality, water quantity, and water quality
- Have adequate access to health care
- Lower economic diversification in rural areas

Ho-Chunk Nation

- Though Nation-specific data is difficult to obtain, health outcomes are likely poorer than state average
- Though members reside in many areas, as a sovereign entity the Ho-Chunk Nation places an extremely high value on protecting natural environments, whether these be tribal lands, lands on which tribal members reside, or beyond.
- Has an active environmental health program and is initiating its own air quality monitoring efforts.
- Exhibits adequate access to health care provided by tribal and non-tribal entities

VULNERABLE POPULATIONS

Vulnerable populations are groups that may experience health effects from a proposed project more intensely or at a greater rate than the general population. Vulnerable populations may include elderly, children, those with low educational attainment, or the impoverished. Within the Level 1 partner communities, these populations tend to be quite small in number and dispersed. With few exceptions, it is difficult to identify their location in relation to sand mining operations. It should also be noted that within the western region, certain religious groups (such as the Amish) are also present. However, these groups are generally dispersed, and this HIA did not find that these groups were likely to be differentially impacted by industrial sand mining when compared to other rural residents.

SECTION 4: AIR QUALITY

CONNECTION BETWEEN AIR QUALITY AND HEALTH

Many who oppose industrial sand mining in western Wisconsin have expressed concern over the potential health risks from air quality impacts by industrial sand operations. During the scoping phase of this assessment, Level 1 and Level 2 partners prioritized two air quality topics for consideration: particulate matter and respirable crystalline silica.

PARTICULATE MATTER

Particulate matter (PM) refers to *any* solid particles present in air. Examples of particulate matter include mold, dust, soot, and metals. Many potential sources of particulate matter exist all around us, including fires, industrial processes, agricultural tilling, unpaved roads, power plants, and diesel vehicles. Particulate matter is noteworthy because high levels of it may exacerbate respiratory and cardiovascular conditions, decrease lung function, and increase mortality.[1] Certain populations, such as those with chronic respiratory conditions, children, and the elderly, may be especially sensitive to particulate matter.[2]

RESPIRABLE CRYSTALLINE SILICA

In addition to the level of particulate matter, stakeholder representatives also expressed concern about how much of the particulate matter in ambient air is composed of crystalline silica (the silica fraction) and whether the silica particles are small enough to be inhaled past the upper airway and into the lungs (respirable silica). Prolonged exposure to substantial levels of respirable crystalline silica, such as occupational exposure, may lead to silicosis, lung cancer, and other airway diseases.[3] The health risks from prolonged respirable crystalline silica exposure are most common among workers in occupations associated with cutting, grinding, or crushing of silica grains, such as sandblasting, stone quarrying, and others. Silicosis and silica-related diseases are considered an occupational health hazard for those exposed to high levels of respirable crystalline silica dust over extended periods of time, often many years.[4,5] Environmental exposure (exposure to levels of respirable crystalline silica that are commonly present in ambient air) have not been associated with a high risk for respiratory illness. Respirable crystalline silica concentrations below published chronic reference levels are commonly present in ambient air, and can come from sources as diverse as agriculture, unpaved roads, and construction activity.[6] Silica is one of the most common minerals in the earth's crust and is not unique to industrial sand, or the Midwest.[7]

FOCUS OF THIS SECTION

This section focuses on potential health risks of particulate matter and respirable crystalline silica resulting from direct excavation, stockpiling, processing, and loading of silica sand. Potential health impacts are evaluated in relation to the *community* population; potential *occupational* health effects to industrial sand facility workers are not evaluated in this report. Other potential air emissions associated with sand mining, such as diesel emissions from transportation or other activities, are generally small and highly variable among sand facilities.

EXISTING LOCAL CONDITIONS

PARTICULATE MATTER IN AIR

In general, different sizes of particulate matter originate from different processes and sources (Fig. 4.1[ii]), and these particles are typically present all around us. Particles greater than 10 µm (1 micrometer = 0.000039 inches) in diameter[iii] are generally too large to remain suspended for great distances and if inhaled, are (to a large extent) filtered out by the nose and upper airway.[8] As a result, most health studies that investigate particulate matter are conducted on exposure related to PM10. PM10 refers to particles less than or equal to 10 µm, (approximately one-sixth the width of a human hair or smaller), which is small enough to travel into the upper airway.[iv] PM4 refers to particles less than or equal to 4 µm[v] (0.00016 inches, approximately 15 times smaller than the width of a human hair) and is the size range widely referenced by regulatory agencies that monitor particulate matter for occupational health hazards.[9,10] This is the size fraction believed to be able to travel past the upper airway and PM4 is generally interchangeable with 'respirable' in air quality literature. Fine particles, defined as PM2.5 (particles less than 2.5 µm in diameter), are generally considered to be the most hazardous to human health, as they can travel deep into the lungs.[11] PM2.5 is dominated by particulates formed from

---

[ii] Note that the graphic illustrates particles based on physical diameters. All OSHA, NIOSH, and EPA particulate matter regulations and sampling procedures are based on aerodynamic diameters rather than physical diameters. Aerodynamic diameter takes into account particle shape and density. For example, a particle (such as a sand grain) with a physical diameter of 65 µm and a reasonable specific density for earth materials (~2.5 g/cm^3) is over *600 times* more massive than a particle with an aerodynamic diameter of 10 µm.

[iii] Aerodynamic diameter, not physical diameter. Aerodynamic diameter is defined as the diameter of a sphere of unit density (1000 kg/m^3) having the same aerodynamic properties as the irregular particle being considered. By referring to the aerodynamic diameter of a particle, irregular particles of different densities or shapes, but that behave similarly in air, are treated the same. For example, a particle (such as a sand grain) with a physical diameter of 65 µm and a reasonable specific density for earth materials (~2.5 g/cm^3) is over 600 times more massive than a particle with an aerodynamic diameter of 10 µm.

[iv] The PM10 size range covers all particulate matter captured with a 50% cut size efficiency at 10 micrometer aerodynamic diameter in an EPA reference method-based sampler or equivalent sampler having a well-defined size-efficiency curve.

[v] PM4 size range covers all particulate matter captured with a 50% cut size efficiency at 4 micrometer aerodynamic diameter in a NIOSH reference method-based sampler or equivalent sampling having a well-defined size efficiency curve.

transportation or combustion sources. Note that PM2.5 and PM4 are particle sizes included as subsets of PM10.

	Level of standard	Averaged time that sample represents	How samples are compared to the standard
PM10	150 µg/m^3	24 hours	Standard not to be exceeded more than once per year on average over 3 years
PM2.5	35 µg/m^3	24 hours	98th percentile of measurements, averaged over 3 years
	12.0 µg/m^3	1 year	Annual mean, averaged over 3 years

Table 4.1. Primary National Ambient Air Quality Standards for PM10 and PM2.5.

The Wisconsin Department of Natural Resources operates an air quality monitoring network to monitor PM2.5 and other pollutants throughout the state. These monitors are not specific to locations where industrial sand mining occurs; rather, they monitor community-level air quality statewide. Recent data indicate historical and present PM2.5 concentrations to be highest in the metropolitan areas of Madison and Milwaukee, though national air quality standards were not exceeded in these locations for extended periods.[12] Throughout Wisconsin, PM2.5 concentrations have been generally decreasing since 2008, and all Wisconsin counties are currently compliant with the daily and annual PM2.5 air quality standards.[13] Two PM2.5 monitors are present within the geographic area of this assessment. A third monitor is present in Taylor County (Fig. 4.2).

Throughout Wisconsin, PM2.5 concentrations have been generally decreasing since 2008, and all Wisconsin counties are currently compliant with the daily and annual PM2.5 air quality standards

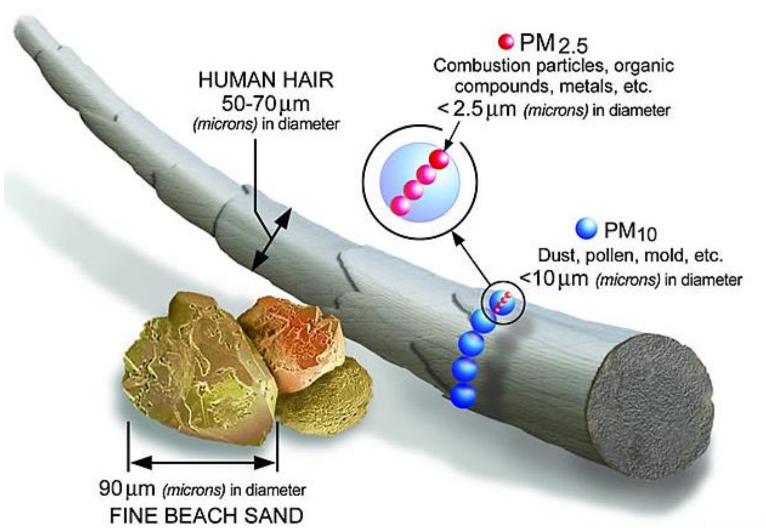


Figure 4.1. Particulate matter sizes from different sources. Particulate matter at 4 µm and below is considered respirable, or able to travel past the upper airway when inhaled. Silica sand grains mined in Wisconsin are well above the respirable size fraction, though there may be a small fraction of crystalline silica particles within the sandstones that are respirable[i]. Image courtesy of the U.S. EPA.

PARTICULATE MATTER MONITORING AT INDUSTRIAL SAND FACILITIES

Air emissions from industrial sand mining and processing facilities vary within the industry and by mine location; they may result from activities related to heavy equipment use, excavation and stockpiling, blasting, materials transport (loading, unloading, conveyors, uncovered trucks), and drying.[14] In Wisconsin, the Wisconsin Department of Natural Resources (WDNR) has been designated by the US Environmental Protection Agency (U.S. EPA) to implement the provisions of the federal Clean Air Act for industrial sand mines. Particulate matter, air monitoring, and fugitive dust are regulated under Ch. NR 415 Wis. Adm. Code *Control of Particulate Emissions*.

Fugitive dust plans are required by the Wisconsin Department of Natural Resources to manage the potential for dust to escape off-site.

Industrial sand facilities are also regulated through Ch. NR 440 *New Source Performance Standards* (particulate matter and opacity) and Ch. NR 445 *Hazardous Air Pollutants*. Air quality limits provided by WDNR air quality permits are determined based on computer-modeled maximum potential emissions from the facility and background (existing) air quality.[15] Sand mines are also required by NR 415 to write and follow a WDNR-approved fugitive dust plan. Fugitive dust plans are site-specific, but commonly include provisions for using water on roads and stockpiles, paving roads, following posted speed limits on the mine sites, minimizing dust production during blasting, and conducting other site-specific activities.[16] Adherence to the fugitive dust plan is evaluated during inspections by the WDNR. The WDNR Air Program conducts at least one full and two partial inspections at each active facility, each year (R. Walls, personal communication, October 21, 2015).

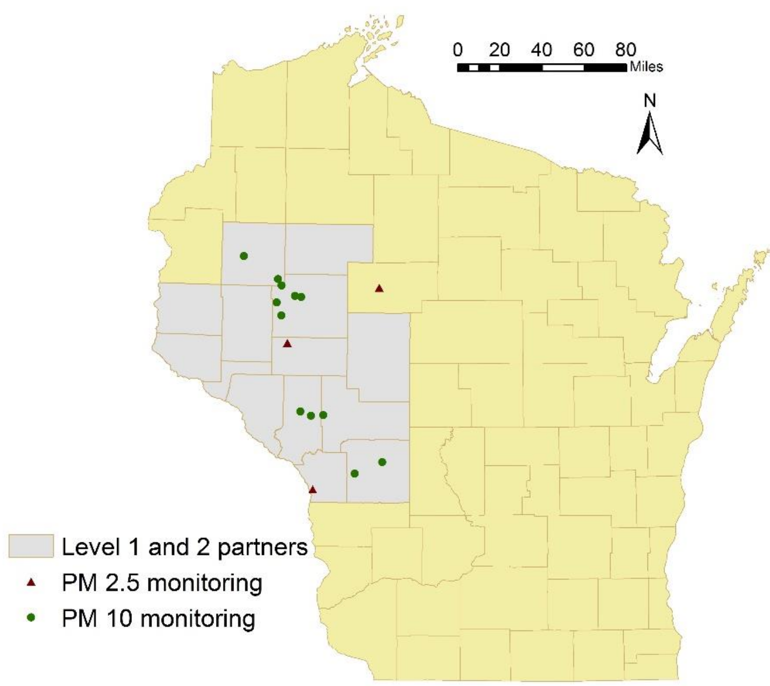


Figure 4.2. Locations of PM10 monitoring at industrial sand facilities in western Wisconsin. PM2.5 monitors shown are part of WDNR statewide particulate monitoring system. Multiple monitors at a single facility are not represented. Data source: Wisconsin Department of Natural Resources.

All air monitoring equipment and operational procedures for industrial sand mines are required to meet U.S. EPA standards for particulate matter monitoring.[17] As of October 2015, PM10 data from 14 monitors in operation at 12 facilities were publically available from the WDNR (Fig. 4.2).[18] The WDNR provides technical review and approval for monitoring plans, audits air monitoring equipment, and reviews monitoring results. Part of this review accounts for appropriate placement of air monitors with respect to prevailing wind direction, freedom from obstructions, and consideration for vulnerable populations that may be within a close proximity to a mine (J. Treutel, personal communication, July 7, 2015). Figure 4.3 shows PM10 data collected at industrial sand mines and processing facilities in western Wisconsin from 2010 to 2015. Facilities with at least one year of data are shown.[19]

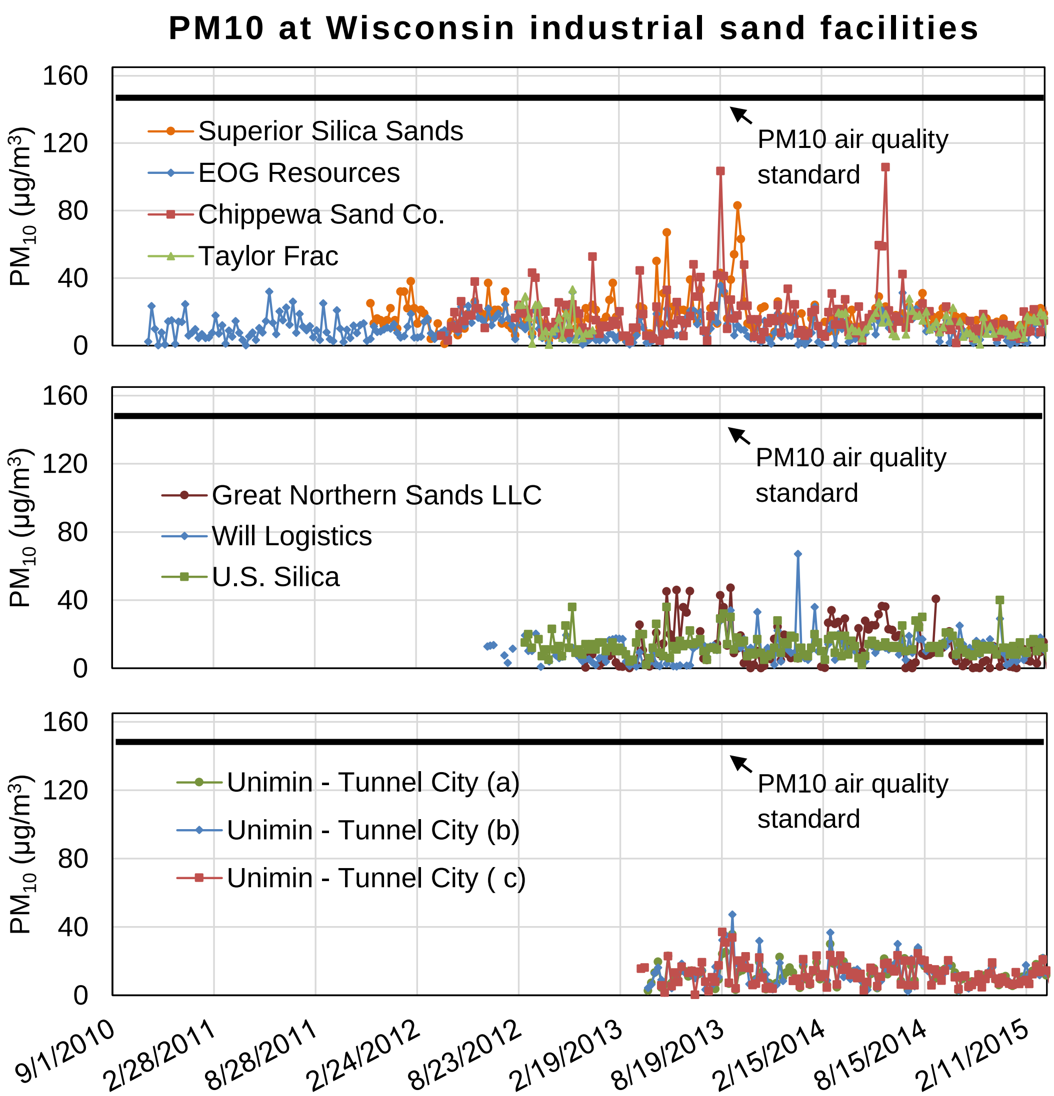


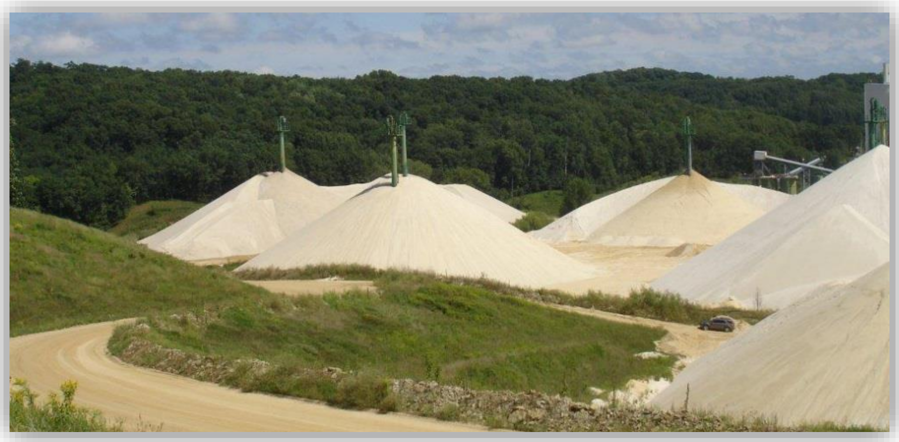
Figure 4.3. PM10 data from air monitors at industrial sand mining and processing locations in western Wisconsin. Data have undergone quality assurance by WDNR. Samples were collected every six days and represent a 24-hour average of PM10 concentration. Elevated values that significantly exceed the average measurements have been attributed to exceptions to standard operations, such as road construction, new mining activity, and deviation from fugitive dust plans (e.g. water truck out of service). Note that the standard indicated is not to be exceeded more than once per year on average over 3 years.

All PM10 measurements collected at the 14 different industrial sand mine monitoring locations in western Wisconsin have been below the EPA primary standard for protection of public health.

The National Ambient Air Quality Standard for PM10 is 150 µg/m³ (microgram per cubic meter). A potential PM source is considered compliant with the PM10 standard if the PM10 measurement doesn't exceed 150 µg/m³ more than once per year on average over three years.[20] This measure is the *primary standard*, that is, the standard which is most protective of public health including sensitive populations such as asthmatics, children, and elderly. As shown in Fig. 4.3, all of the PM10 measurements collected at the 14 different industrial sand mine monitoring locations have been below the primary standard.

Industrial sand mining in eastern Minnesota is very similar to western Wisconsin and data collected in Minnesota can help to further the understanding of potential environmental and health impacts of the industrial sand industry. Air quality data have also been collected and made publically available for several industrial sand facilities in Minnesota through the Minnesota Pollution Control Agency.[21] PM10 measurements from the Shakopee Sands facility, Titan Lansing transloading facility, and Jordan Sands facility have not indicated an exceedance of the PM10 primary standard since monitoring was initiated between 2012 and 2014.

In this assessment, datasets collected in accordance with ambient air sampling operating standards (which are set by the U.S. EPA and supported in the published literature) were more heavily weighted when determining the potential risks to human health from particulate matter. It should be noted that researchers have conducted additional community-level ambient air quality monitoring for PM2.5 in western Wisconsin in the vicinity of industrial sand facilities. Walters, et al. (2015) measured PM2.5 at four industrial sand sites, collecting a total of six measurements ranging in length from approximately 6 hours to 25 hours in length.[22] The equipment and methods used in this study did not meet the EPA Federal Reference Method for ambient air data collection, and not all samples represented a full 24-hour average. In addition, wind direction, wind speed, and distance to other possible particulate sources were not published as part of this study. Based on these deviations from approved air monitoring standards and the partial nature of the dataset, the research team did not find the study contributed to understanding of the issue.



Washed silica sand, stored in piles before drying and shipment. Courtesy Badger Mining Corporation.

RESPIRABLE SILICA MONITORING AT INDUSTRIAL SAND FACILITIES

To address community concern for potential health impacts from respirable crystalline silica, studies have been conducted in western Wisconsin to sample for and test the amount of crystalline silica in respirable particulate matter. In Chippewa and Barron County, PM4 samples were collected simultaneously at upwind and downwind locations near three industrial sand mines and one sand processing plant for over two years.[23] The air samplers were operated in accordance with U.S. EPA procedures and National Institute for Occupational Safety and Health (NIOSH) standards. Over two years, 2,128 24-hour samples were collected at four locations. All samples were analyzed for silica content. The *annual average* of the values measured were compared to the California Office of Environmental Health Hazard Assessment (OEHHA) 70-year chronic (long-term) reference exposure level (REL) of 3.0 μg/m³. The annual average respirable crystalline silica concentrations at all facilities evaluated were well below (less than 10%) the REL for ambient respirable crystalline silica. This health-based value represents the level below which health effects are unlikely in sensitive populations. Adverse health effects are not anticipated from exposure to respirable crystalline silica below this level, even if the exposure occurs over a lifetime.

The study referenced this California standard because there is currently no U.S. EPA standard for crystalline silica, and Wisconsin has not adopted a REL for ambient respirable crystalline silica. The study also revealed no consistent trend of increased respirable crystalline silica at the downwind location when compared to the upwind location (upwind and downwind designations were made for each sampler based on wind direction measurements on the sampling day). These findings suggest that industrial sand facilities are not a consistent or substantial source of respirable crystalline silica.

Monitoring in Chippewa and Barron counties showed there was no consistent trend of increased respirable crystalline silica at downwind air quality monitors when compared to upwind monitors.

The results of the Chippewa and Barron County study are similar to that of a respirable crystalline silica study conducted near sand facilities in Maiden Rock, Sparta, and Downing, Wisconsin.[24] In this study, 657 24-hour samples were collected and analyzed for silica content. The results indicated that average respirable crystalline silica concentrations at all three locations were within the range of local background concentrations and well below (less than 20%) the California OEHHA REL of 3.0 μg/m³. Results from these locations were also compared to data collected at Cataract Green, a green field planned to be developed as a mine in the future. There was no mining or agricultural activity at or around Cataract Green. The respirable crystalline silica data from the Cataract Green control site were similar to the data collected at the sand facilities. In addition, no sampling sites demonstrated significant differences in respirable crystalline silica concentration that could be attributed to wind speed.

Respirable crystalline silica has also been measured near industrial sand facilities in Minnesota. The Minnesota Department of Health recently adopted the chronic REL of 3 μg/m. Average values of respirable crystalline silica from two separate studies—a 17-month study near the Shakopee Sands facility and a nine-month study at the Jordan Sands facility—did not exceed this REL.[25,26] Respirable crystalline silica sampling was also conducted in the communities of Winona, MN and Stanton, MN. The Winona monitor measured air quality impacts that may be associated with mining-related truck traffic and activities. Stanton does not have any industrial sand related facilities or transportation, but is a rural area with unpaved roads and farm fields. This site served to measure background concentrations. There were more days of detectable levels of respirable crystalline silica at Stanton than Winona, though average respirable silica concentrations in both locations were a fraction of the REL.[27]

Overall, the respirable crystalline silica concentrations measured in Minnesota are very similar to those measured in Wisconsin. These results provide independent confirmation of the Wisconsin respirable crystalline silica concentrations: multiple facilities in various locations sampled by different technicians indicate similar levels of respirable crystalline silica that are below health-based exposure levels.

COMPARISON OF PARTICULATE MATTER TO REGIONAL BACKGROUND CONCENTRATIONS

The Chippewa and Barron counties study also found that PM4 concentrations measured at two locations in Chippewa County mirrored fluctuations of fine particulate matter (PM2.5) measured by WDNR in neighboring Eau Claire County (Fig. 4.4). The primary standard for PM2.5 is 12 $\mu g/m^3$ as an annual mean, averaged over three years. Figure 4.4 shows that in 2013, PM2.5 collected by the WDNR monitor fluctuated, but on average was below the primary standard. PM4 measured near mine sites also fluctuated, and these variations were nearly in sync with the WDNR monitor in Eau Claire. These results indicate that the Chippewa Falls monitors were highly influenced by regional air quality, as demonstrated by the similarity to the Eau Claire monitor. Similarity between these two monitoring points support the conclusion that these facilities did not substantially contribute particulate matter within the respirable size fraction. This dataset also demonstrates the importance of collecting many points and evaluating air quality based on data collected over long time periods. Short-term air quality measurements may not accurately represent natural variability in air quality, such as seasonal or weather-related changes.

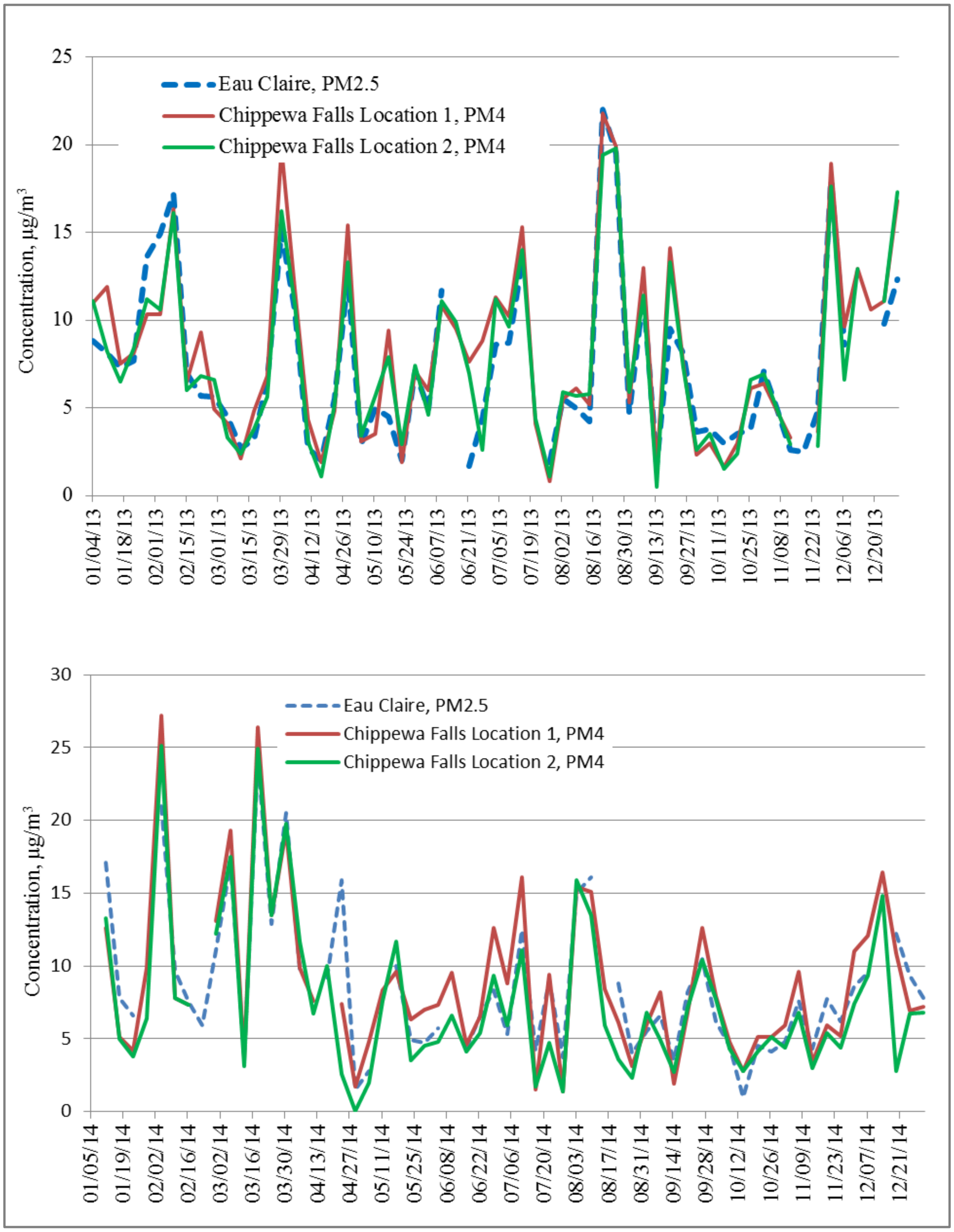


Figure 4.4. 2013 and 2014 particulate matter (PM4) measured at the Chippewa Falls sand processing plant on opposite sides of the facility, compared to PM2.5 measured in Eau Claire. Samples were collected every 6th day; axis indicates every 14th day for legibility. From Richards, J., & Brozell, T. (2015). Assessment of community exposure to ambient respirable crystalline silica near frac sand processing facilities. Atmosphere, 6(8), 960–982.

POTENTIAL HEALTH IMPACTS

HOW WILL INDUSTRIAL SAND MINING IMPACT PM10?

Ambient PM10 is generated by a wide range of natural and human activities. Determining the sources of ambient particulate matter is difficult, and PM10 that can be attributed to industrial sand facilities will be variable depending on daily weather and facility operations. Industrial sand operations such as blasting, excavation, processing, stockpiling, and loading for transport are a potential source of ambient particulate matter. However, PM10 monitors at 12 different facilities in western Wisconsin have not indicated an exceedance of the primary air quality standard, and this is supported by data collected by the WDNR since late 2010 (Fig. 4.3). The health-based PM10 standard of 150 $\mu g/m^3$ is intended to protect even the most vulnerable populations. However, individual sensitivity to particulate matter levels and to particulate matter composition (type and size of particle) are variables that may factor into health effects resulting from exposure to particulate matter.

High levels of particulate matter may serve as asthma triggers for some individuals.[28] At the time of this report, there were no comprehensive epidemiological studies published to evaluate respiratory illness trends in western Wisconsin. To address the subject, the HIA research team evaluated data for hospital emergency department (ED) visits for asthma from 2002 to 2013. This data was requested from the Wisconsin Environmental Public Health Tracking (EPHT) Program at the Wisconsin Division of Public Health for the 14 counties included in this assessment. Nine of the counties did not indicate a statistically significant trend in asthma emergency department visits, and the five counties that did (Buffalo, Chippewa, Jackson, Pierce, Trempealeau) indicated both increases and decreases in asthma emergency department visits. Overall, these data do not show a clear trend in emergency visits due to asthma in western Wisconsin since 2002. This analysis looks only at emergency department visits, and as such provides a selected population perspective. Many factors could influence rates of ED visits for asthma, including the quality of health care at local clinics as well as regional programming to address asthma control. Additional detail on asthma data and statistical analysis is available in Appendix A.

Based on air quality monitoring data to date, PM10 particulate matter associated with industrial sand mining in Wisconsin appears unlikely to affect human health, as long as regulated air quality standards are met. Air quality monitoring and dissemination of results will continue to be important both to ensure compliance and public understanding. The ambient air standards for particulate matter are meant to minimize health impacts to vulnerable populations such as children, the elderly, and those with pre-existing respiratory diseases. However, some individuals may be especially sensitive to air quality. Continued monitoring of community-level ambient air quality (not exclusively at industrial sites) will be useful to identify periods of elevated risk for the highly sensitive.

HOW WILL INDUSTRIAL SAND MINING IMPACT AIRBORNE RESPIRABLE CRYSTALLINE SILICA?

Industrial sand facilities are not sources of respirable crystalline silica at levels that pose a community-level health hazard.

Airborne respirable crystalline silica is a well-established occupational health hazard in industries where workers could be regularly exposed to fractured silica particles small enough to travel deep into the lungs.[29] As a result, industrial sand mine workers are regularly monitored for respirable crystalline silica according to Mine Safety and Health Administration (MSHA) regulations.[30] It is important to note that the risk for *community* exposure to respirable crystalline silica is different from *occupational* exposure. Silica sand is desirable for oil and gas production due to its extreme hardness, and this hardness is one of the reasons for low concentrations in ambient air. Because of the natural hardness of silica, very high levels of energy are needed to fracture the grains into respirable size. Stockpiles, loading facilities, and processing facilities are the most likely sources of respirable crystalline silica; however, numerous monitoring datasets from industrial sand facilities in Minnesota and Wisconsin indicate that these facilities are not substantial sources of ambient respirable crystalline silica. Rather, these studies have indicated that the risk of community exposure near an industrial sand facility is the same as exposure regionally.[31]

SUMMARY

After analyzing available data, reviewing published literature, and consulting with subject area experts, the HIA research team characterized the potential for health effects as a result of industrial sand mining and processing impacts to PM10 and respirable crystalline silica:

PM10

Likelihood - Based on the available data collected at industrial sand facilities and on published epidemiologic literature, health effects from the impact of industrial sand mining on community-level air quality related to PM10 are **unlikely**.

Intensity - Available data do not indicate that the levels of PM10 are high enough to contribute to health effects at the community level. Though there may be some individuals who are exceptionally sensitive, the intensity of health effects for vulnerable populations (children, elderly, those with existing respiratory conditions) and the community are anticipated to be **low.**

Distribution - The distribution of those potentially impacted would be residents in proximity to the mine, but overall will be **site-specific and variable** across the western region.

Evidence - Evidence is **very strong** for the conclusion that industrial sand facilities are unlikely to substantially impact PM10 to the extent of exceeding air quality standards. The evidence is based on site-specific PM10 data collected using methods that meet federal standards. These data have been reviewed by air quality experts at WDNR and made publically available.

RESPIRABLE CRYSTALLINE SILICA

Likelihood - Based on the available data collected at industrial sand facilities and on published epidemiologic literature, it is unlikely that community members will be exposed to respirable crystalline silica from industrial sand mining as currently regulated; therefore, health effects from exposure are **unlikely.**

Intensity - Available data do not indicate that levels of respirable crystalline silica near industrial sand facilities or nearby communities exceed the long-term reference exposure level, and as a result, the intensity of health effects at the community level are anticipated to be **low.**

Distribution - The population most vulnerable to significant exposure (and therefore to the resultant health effects) of respirable crystalline silica would be industrial sand mine and processing facility workers. Existing data and published research do not indicate a community-level risk for exposure to respirable silica from industrial sand operations.

Evidence - Evidence is **very strong** for the conclusion that industrial sand facilities, as currently regulated in Wisconsin, are unlikely to substantially impact levels of respirable crystalline silica on a community level. The evidence is based on site-specific respirable crystalline silica data collected in Wisconsin and Minnesota. This data was collected according to federal air monitoring standards, reviewed by air quality experts, and made publically available.

Pond and railcar loop adjacent to an industrial sand processing facility, western Wisconsin. Courtesy: SmartSand

	Likelihood of potential health effects	Intensity of potential health effects	Distribution of potential health effects	Evidence for likelihood of health effects
PM10	Unlikely	Low	Surrounding	Very strong
Respirable crystalline silica	Unlikely	Low	Occupational	Very strong

Key to Effects Characterization[vi]

Likelihood: How likely is it that a given health effect will occur in association with industrial sand mining

Insufficient evidence – The likelihood of a health effect cannot be judged based on available evidence
Unlikely – It is not likely that health effects will occur
Possible – Health effects are plausible
Likely – Health effects are probable
Very Likely – Health effects are highly probable

Intensity: The magnitude of the potential positive or negative health effects associated with industrial sand mining

Insufficient evidence – Evidence is inadequate to judge the intensity of health effects
Low – There are likely to be no or minimal health effects
Medium – Health effects may be minor; negative effects would be non-disabling
High – Positive or negative health effects may be considerable

Distribution: the expected impact based on proximity to an industrial sand facility[vii]

Occupational – Health effects, if any, may be limited to employees of the facility
Adjacent – Health effects, if any, may be experienced by individuals very near to a facility
Surrounding – Health effects, if any, may be experienced by individuals in the same community as a facility
Regional – Health effects, if any, may be experienced by individuals in western Wisconsin

Quality of evidence for the likelihood of health effects

None – There is no available evidence
Weak – Evidence is primarily anecdotal, based on media stories or individual reports
Moderate – Evidence is based on expert opinion, reports from experts, academics, industry, government, and others
Strong – Evidence is based on published studies not specific to western Wisconsin
Very Strong – Evidence is based on published studies specific to western Wisconsin

This summary represents our best understanding of potential health effects from PM10 and respirable crystalline silica based on the available data and understanding of the science. Scientific advancement may provide additional data that should be considered by experts in the field.

vi It should be noted that effects characterization relies on both qualitative and quantitative data and methods. It is also based on the evidence available at the time that this assessment is completed. As new evidence becomes available, effect characterization may change.

vii This categorization doesn't imply that all individuals within the geographic area will experience health effects, only that if health effects occur, the geographic area identified is relevant.

RECOMMENDATIONS

The analysis of potential industrial sand mine impacts to PM10 and respirable crystalline silica indicated that health effects were unlikely. However, public concern around potential impacts to air quality and subsequent health effects is substantial. For proposed or existing industrial sand facilities, this assessment recommends:

1. Development of a set of voluntary industry standards, such as those suggested by the Wisconsin Industrial Sand Association (WISA) Code of Conduct, which may help to promote thoughtful review, policy and project development, and positive relationships with community members. The WISA Code of Conduct promotes, among other things:
    a. Open dialog with stakeholders.
    b. Consideration of stakeholder perspectives and appropriate action to minimize community impacts of industrial sand operations.
    c. Design and operation of safe and environmentally sound industrial sand facilities.

    Examples of the WISA code and other sustainability principles are included in Appendix B.
2. Representation from local, tribal, or regional public health departments as part of the local permitting or review process. This may improve positive health outcomes and minimize negative health effects. Public health representatives can provide a "health lens" to permitting discussions and serve to promote and protect public health interests in this process.

The following recommendations and considerations may also reduce negative health impacts and promote positive health outcomes. These recommendations and considerations may not be applicable for all industrial sand facilities, but may be useful for decision makers who are considering industrial sand mine applications.

	Recommendations
Existing Facilities	**To minimize potential negative health effects, it is recommended that policymakers:** 1 Encourage adoption of standards, such as those suggested by the WISA Code of Conduct 2 Promote transparency and public understanding by making air quality data collected at sand mines and processing facilities available to the public
Proposed Facilities	**To minimize potential negative health effects, it is recommended that policymakers:** 1 Encourage adoption of standards, such as those suggested by the WISA Code of Conduct 2 Promote transparency and public understanding by making air quality data collected at sand mines and processing facilities available to the public
	Considerations
Existing and Proposed	If the community is concerned about the validity of monitoring or reporting of air quality data, consider independent verification of methods and report results.

[1] Anderson, J.O., Thundiyil, J.G., & Stolback, A. (2011). Clearing the air: A review of the effects of particulate matter air pollution on human health. *Journal of Medical Toxicology*, *8*, 166-175.
[2] US Environmental Protection Agency. (2015). Particulate Matter Health Effects. *Available* from http://www3.epa.gov/pm/health.html.
[3] Centers for Disease Control and Prevention. (2002). *Health Effects of Occupational Exposure to Respirable Crystalline Silica* (DHHS [NIOSH] Publication No. 2002-129). Retrieved from http://www.cdc.gov/niosh/docs/2002-129/pdfs/2002-129.pdf.
[4] Centers for Disease Control and Prevention. (2002). *Health Effects of Occupational Exposure to Respirable Crystalline Silica* (DHHS [NIOSH] Publication No. 2002-129). Retrieved from http://www.cdc.gov/niosh/docs/2002-129/pdfs/2002-129.pdf.
[5] US Environmental Protection Agency. (1996). *Ambient levels and noncancer health effects of inhaled crystalline and amorphous silica: Health Issue Assessment* (EPA/600/R-95/115). Washington, DC: Office of Research and Development.
[6] Richards, J., & Brozell, T. (2015). Assessment of community exposure to ambient respirable crystalline silica near frac sand processing facilities. *Atmosphere, 6*, 960-982.
[7] Centers for Disease Control and Prevention. (2002). *Health Effects of Occupational Exposure to Respirable Crystalline Silica* (DHHS [NIOSH] Publication No. 2002-129). Retrieved from http://www.cdc.gov/niosh/docs/2002-129/pdfs/2002-129.pdf.
[8] Anderson, J.O., Thundiyil, J.G., & Stolback, A. (2011). Clearing the air: A review of the effects of particulate matter air pollution on human health. *Journal of Medical Toxicology*, *8*, 166-175.
[9] Richards, J., & Brozell, T. (2015). Assessment of community exposure to ambient respirable crystalline silica near frac sand processing facilities. *Atmosphere, 6*, 960-982.
[10] Minnesota Environmental Quality Board. (2013). *Report on Silica Sand.* Retrieved from https://www.eqb.state.mn.us/sites/default/files/documents/23.%20March%20Final%20Silica%20Sand%20report.pdf.
[11] Pope III, C. A., & Douglas, D. W. (2006). Health effects of fine particulate air pollution: Lines that connect. *Journal of the Air & Waste Management Association, 56(6),* 709-742.
[12] Wisconsin Department of Natural Resources. (2015). *Wisconsin Air Quality Trends* (AM-526-2015). Madison, WI. Retrieved from http://dnr.wi.gov/files/PDF/pubs/am/AM526.pdf.
[13] Wisconsin Department of Natural Resources. (2015). *Wisconsin Air Quality Trends* (AM-526-2015). Madison, WI. Retrieved from http://dnr.wi.gov/files/PDF/pubs/am/AM526.pdf.
[14] Wisconsin Department of Natural Resources. (2012). *Silica Sand Mining in Wisconsin.* Madison, WI.
[15] Wisconsin Department of Natural Resources. (2012). *Silica Sand Mining in Wisconsin.* Madison, WI.
[16] Wisconsin Department of Natural Resources. (2012). *Silica Sand Mining in Wisconsin.* Madison, WI.
[17] Wisconsin Department of Natural Resources. (2015). [Interactive map of air monitoring locations near sand mines]. *Air monitoring map for industrial sand mines/processing plants.* Retrieved from http://dnr.wi.gov/topic/Mines/AQSandMap.html.
[18] Wisconsin Department of Natural Resources. (2015). [Interactive map of air monitoring locations near sand mines]. *Air monitoring map for industrial sand mines/processing plants.* Retrieved from http://dnr.wi.gov/topic/Mines/AQSandMap.html.
[19] Treutel, J. (2015, March 18). *Sand mining monitoring in Wisconsin.* [PowerPoint slides]. Industrial Sand Mining Training, Black River Falls, Wisconsin.
[20] US Environmental Protection Agency. (n.d.). PM-10 AIRTrends summary. Retrieved from http://www3.epa.gov/airtrends/aqtrnd95/pm10.html.
[21] Minnesota Pollution Control Agency. (n.d.). [Graph illustration of facility air quality data]. *Air monitoring at Minnesota silica sand facilities*. Retrieved from http://www.pca.state.mn.us/index.php/air/air-quality-and-pollutants/air-pollutants/silica-sand-mining/air-monitoring-data-at-minnesota-silica-sand-facilities.html
[22] Walters, K., Jacobson, J., Kroening, Z., & Pierce, C. (2015). PM2.5 airborne particulates near frac sand operations. *Journal of Environmental Health*, *78(4)*, 8-12.
[23] Richards, J., & Brozell, T. (2015). Assessment of community exposure to ambient respirable crystalline silica near frac sand processing facilities. *Atmosphere, 6*, 960-982.
[24] Richards, J., & Brozell, T. (2015). Fenceline PM4 crystalline silica concentrations near sand mining and processing facilities in Wisconsin. *Mining Engineering, 67(10),* 53-59.
[25] Minnesota Pollution Control Agency. (2015, October). *Shakopee Sand (previously Great Plains Sand) Ambient Air Monitoring, Jordan, Minnesota*. Retrieved from http://www.pca.state.mn.us/index.php/view-document.html?gid=19962.
[26] Minnesota Pollution Control Agency. (2015, October). *Jordan Sands Ambient Air Monitoring, Mankato, Minnesota.* Retrieved from http://www.pca.state.mn.us/index.php/view-document.html?gid=23378.
[27] Minnesota Pollution Control Agency. (2015, May). *Winona – Community Ambient Air Monitoring, Winona, Minnesota*. Retrieved from http://www.pca.state.mn.us/index.php/view-document.html?gid=21302.

[28] Anderson, J.O., Thundiyil, J.G., & Stolback, A. (2011). Clearing the air: A review of the effects of particulate matter air pollution on human health. *Journal of Medical Toxicology*, *8*, 166-175.
[29] US Environmental Protection Agency. (1996). *Ambient levels and noncancer health effects of inhaled crystalline and amorphous silica: Health Issue Assessment* (EPA/600/R-95/115). Washington, DC: Office of Research and Development.
[30] Wisconsin Industrial Sand Association. (2013, May). *Crystalline silica*. Retrieved from http://www.wisconsinsand.org/assets/Crystalline-Silica-Final-May-2013.pdf
[31] Richards, J., & Brozell, T. (2015). Assessment of community exposure to ambient respirable crystalline silica near frac sand processing facilities. *Atmosphere, 6*, 960-982.

SECTION 5: WATER RESOURCES

CONNECTION BETWEEN WATER RESOURCES AND HEALTH

Water is a critical component for healthy living, as it is essential for human body function, sanitation, and growing and sustaining food sources. Worldwide, unsafe water as well as poor sanitation and hygiene account for approximately 5.3% of all deaths.[1] Even in developed nations, low-quality drinking water and poor sanitary control and sewage disposal are responsible for a considerable burden of disease.[2] The connection between water and health is based on two general attributes: water quality and water quantity. Both are important for healthy growth and development and can be compromised when existing water resources or waste products are poorly managed. Water ecosystems play an important role in purifying and providing water resources, and urban and rural land development can threaten the quality and quantity of water in these ecosystems, potentially resulting in acute or chronic health impacts as well as impacts to the environment.[3]

FOCUS OF THIS SECTION

This section focuses on the potential impacts to water quantity and water quality associated with industrial sand operations. It is outside the scope of this assessment to evaluate regional impacts to water resources from the industry as a whole.

EXISTING LOCAL CONDITIONS

Water Use in Wisconsin –Western Wisconsin is characterized by plentiful, high-quality groundwater aquifers that generally meet the groundwater demands in the area. Groundwater also supplies a wide variety of water ecosystems in the region, including lakes, rivers, and wetlands. Groundwater is used to support many industries including power generation, food processing, ethanol production, and a variety of types of agriculture, such as cranberry, vegetable, and dairy production. In 2013, water withdrawal for power generation, municipal water, irrigation, and cranberry farming accounted for 91% of the 2.12 trillion gallons withdrawn statewide (enough to cover the state in approximately two inches of water).[4] In 2013, agricultural irrigation alone accounted for water withdrawal of 106 billion gallons (over 290 million gallons per day), or approximately 5% of total water withdrawal in Wisconsin.[5]

Water Use in Industrial Sand Mining - Industrial sand mines also use water in the processing of their final product, and in 2013, industrial sand mining facilities in

Industrial sand facilities accounted for 0.1% of all statewide water usage in 2013.

Wisconsin withdrew approximately 2 billion gallons of water. This is equivalent to less than 0.1% of all surface and groundwater use across the state.[6] In areas with a high number of mines, the percentage groundwater withdrawal by industrial sand mining locally, compared to groundwater withdrawal for other uses in the area, is likely to be higher than 0.1%. For example, in northwestern Chippewa County and neighboring parts of Dunn and Barron counties, industrial sand withdrawal contributed to 12% (105 million gallons) of total high-capacity well withdrawal in 2013. This is slightly more than withdrawal for municipal uses (99 million gallons). Withdrawal for irrigation was higher than any other use, with 689 million gallons.[7]

Typically, one or more wells are constructed at sand mines to provide water for sorting and washing the sand to remove fine sand, silt, and clay-sized particles. Wash water may be recycled and reused or discharged, depending on the facility design. Additional water is used for drinking and sanitation at the facility, dust suppression, or transporting slurry (a fluid water and sand mixture).

Facilities that recycle wash water must first remove the silt and clay-sized particles from the water before reuse. This can be done by allowing particles to naturally settle (such as in a settling pond) or by treating the water (in a manner similar to that of a municipal wastewater or drinking water treatment plant). In these closed-loop systems, some water loss occurs from evaporation, infiltration, or incorporation in the fine material removed from the water, and additional water must be withdrawn to replenish the losses. Open-loop systems do not recycle processing water and require replenishment from wells at a higher rate than closed-loop systems.

Water resources regulations - The WDNR enforces several regulations that apply to groundwater use including Ch. NR 140 Wis. Adm. Code *Groundwater Quality*, NR 809 *Safe Drinking Water*, NR 810 *Requirements for the Operation and Maintenance of Public Water Systems* (for facilities that provide drinking water for more than 25 people, more than six months throughout the year), NR 812 *Well Construction and Pump Installation*, and NR 820 *Groundwater Quantity Protection*.

Wells capable of pumping 70 gallons per minute or greater are classified as high-capacity wells and are also subject to WDNR high-capacity well permit requirements for construction and maintenance.[8] Before high-capacity wells are permitted, the WDNR reviews the well application to determine the possibility for significant impacts the well may have on “waters of the state,” which include public and private wells, streams, lakes, and wetlands.[9] If wells are found to have a possible significant impact, they are either denied or approved with conditions to prevent the occurrence of those impacts. Through this method, the WDNR considers site-specific characteristics such as geology, hydrogeology, pumping rates, nearby existing wells, and hydrology, and evaluates whether the proposed well may cause excessive drawdown (a decrease in elevation) of the water table or other potentially adverse impacts. After high-capacity wells for industrial sand facilities are approved and registered with WDNR, well construction and pumping information is reported annually and is made available to the public through the WDNR searchable groundwater well database.[10]

Local permitting authorities may also carefully examine potential impacts of industrial sand facilities to groundwater and surface water by reviewing conditional use permit applications and mine reclamation plans. Authorities may also require confirmation that the applicant has considered applicable regulations and obtained appropriate permits.

The WDNR also regulates surface water discharge, stormwater discharge, and runoff management. These topics are briefly mentioned in this assessment, but are generally outside the scope of this HIA. The 2012 WDNR report *Silica Sand Mining in Wisconsin* provides additional detail about the industry process and relevant WDNR regulations and we recommend that the reader refers to this WDNR report for more information.

Water-soluble polymer use - Water used for processing at industrial sand facilities may be amended with water-soluble polymers under a WDNR permit. The permit requires that water treatment additive use must be recorded on site.[11] Water-soluble polymers promote the clustering of small particles, which accelerates the water-clarifying process. Treating and reusing water decreases the need for fresh water to be pumped from a well. Not all industrial sand facilities use additives to aid in water treatment; some facilities allow particles to settle naturally in water holding ponds.[12] Some facilities may directly add water-soluble polymers to settling ponds containing water treated during the wash process.

Water- soluble polymers commonly used in industrial sand processing are also used in municipal water and wastewater treatment facilities.

One of two commonly used polymers in the industrial sand industry is polyacrylamide, which is also used in food processing facilities, as a soil stabilizing agent, and in treatment of public drinking water.[13, 14, 15] The concentration of water-soluble polymers added to wash water or settling ponds at mines is variable across the industry. For those facilities that use polyacrylamide, the Wisconsin Industrial Sand Association reports that most facilities typically add 6 to 7 parts per million (ppm)[i] of the polymer to the wash water.[16] The second water-soluble polymer is polyDADMAC, also commonly used to treat municipal drinking water. PolyDADMAC is typically added to wash water at a concentration of 15 ppm.[17] It should also be noted that while polyacrylamide and polyDADMAC are the most common water-soluble polymers used, there may be other additives in use at some facilities and the potential for exposure and health effects from these additives should be evaluated by the regulating authority.

[i] For reference, one part per million is roughly equivalent to one drop of water in a ten gallon tub of water.

POTENTIAL HEALTH IMPACTS

HOW WILL INDUSTRIAL SAND MINING AFFECT GROUNDWATER QUANTITY?

In general, water supply wells have an impact on groundwater, though the magnitude varies with pumping rates, seasonality, geology, surface water, well construction, and many other variables. Pumping from wells can potentially result in health, economic, and environmental impacts, such as adverse changes in water quality, lower water levels in surrounding wells, and negative effects on water ecosystems (wetlands, streams, and lakes).[18] If a drinking water supply well is affected by pumping of groundwater in the area, there is the potential for impacts to an individual's access to the water necessary for daily operation of the person's farm, business, or home.

Negative effects from groundwater pumping to other wells, if any, are expected to be localized.

The amount of groundwater used at industrial sand facilities can be highly variable, and in part depends on facility size and the methods used for recycling the processing water. The time of year (sand washing may only occur seasonally) and the weather (more water is needed for dust control during warmer, drier periods) are also variables that can affect the amount of water used.

The potential does exist for groundwater withdrawal by an industrial sand facility to impact nearby wells, though negative effects can be expected to be localized. The same potential to impact nearby water supply wells exists for other high-capacity wells (such as those used for municipalities or agriculture). Areas with several high-capacity wells in proximity to one another are generally more at risk for negative consequences for water resources.

As of this assessment, the research team is not aware of water quantity issues for private wells that have been directly attributed to industrial sand mines, though possible impacts to private wells have been reported in the media.[19] Some facilities have agreements to repair or replace neighboring wells if impacts occur.[20] In 2012, the Wisconsin Geological and Natural History Survey began a five-year study of high-capacity well pumping and the future of groundwater resources in Chippewa County based on current and anticipated water use.[21] Preliminary findings from the study are available on the Chippewa County website and final results may prove useful to better understand the potential impacts of industrial sand mining, groundwater use by other industries, and future groundwater resources.[22] Additional research to evaluate impacts from high-capacity wells in western Wisconsin is being considered (M. Lehman, personal communication, November 6, 2015).

Health effects are possible if a private well is impacted by pumping from another nearby well. Actual health effects depend on the water demands for residential, farm, or business use, as well as the impact to the well (e.g., occasional loss of water or a completely dry well) and availability of other sources of water. Individuals that experience severe impacts to water quantity such that a new well must be drilled may experience economic losses and disruption to water access for basic needs, such as for drinking, sanitation, and farm or business use. This may result is stress, anxiety, and associated health effects. Individuals that experience only minor impacts to water access may still experience stress and associated health effects. Individuals most likely to experience water quantity issues are residents in proximity to an industrial sand facility, though not all residents will be impacted. In general, it is not anticipated that any special population groups (such as low income or elderly persons) would be particularly vulnerable to water quantity health effects. However, if such individuals were among those whose well was directly impacted, they may have increased difficulty in dealing with both the emotional and financial stressors associated with the situation.

Experts who have a good understanding of geology, hydrogeology, and well construction can evaluate potential impacts to surrounding wells or water ecosystems before pumping begins. The WDNR's application process for high-capacity wells requires a systematic review to avoid substantial health, economic, or environmental impacts from proposed wells. This process takes into account the potential effects of the proposed well within the context of water wells and withdrawal. Independent groundwater modeling can also provide information on potential impacts, or lack thereof, on nearby wells.

HOW WILL INDUSTRIAL SAND MINING IMPACT GROUNDWATER QUALITY?

The three primary chemicals stored and used at mines are

- petroleum for operating equipment at mines and processing operations
- blasting agents
- water-soluble polymers used in sand washing

Throughout the scoping stage of this HIA, the potential for groundwater contamination from water-soluble polymers was the most commonly indicated water quality concern[ii]. Neither polyacrylamide nor polyDADMAC, are associated with adverse human health impacts. There is currently no evidence indicating that water-soluble polymers have impacted water quality at industrial sand processing facilities in Wisconsin or neighboring Minnesota (R. Walls, personal communication June 26, 2015).

Acrylamide, which is present in low concentrations as an impurity in polyacrylamide, is listed as a likely human carcinogen and neurotoxin by the U.S. Environmental Protection Agency (EPA). The U.S. EPA does not have a regulatory limit for acrylamide in water, but does regulate the amount of residual acrylamide allowable in polyacrylamide used in drinking water treatment, such that the effective allowable concentration of acrylamide in drinking water is 0.5 ppb[iii].[23] Acrylamide is also present in fried starchy foods (potato chips, french fries), coffee, tobacco smoke, and other food and household products.[24,25,26] This is the most common route of exposure

[ii] The potential for acrylamide contamination of groundwater was prioritized during scoping. This report acknowledges concern that has been raised regarding the use of chlorinated public water supply by a sand facility and the potential for formation of nitrosomines in the presence of polyDADMAC. Due to the overall rarity of chlorinated water use by mines in the region, the likelihood and potential health effects of this scenario were not evaluated.

[iii] EPA methods 8032A and 8316 can be used for testing water for acrylamide.

> Acrylamide is readily biodegradable and has not been detected in groundwater at Wisconsin or Minnesota industrial sand facilities.

to acrylamide for most people.[27] Health effects from exposure to acrylamide have been found to be most likely for people that work with acrylamide, or live close to where acrylamide is used in high concentrations, such as plastics and food processing plants.[28]

At the reported typical rate of polyacrylamide addition to the clarifying process (6 to 7 ppm), the approximate concentration of the acrylamide monomer is 1 part per billion (ppb)[iv,v].[29] In facilities that recycle wash water, the recycled water will typically have some fresh water and additional water-soluble polymers added. This can increase the amount of residual acrylamide present in the wash water recycling loop[vi]. Depending on how much breakdown of acrylamide occurs during the recycling process, acrylamide concentrations in the water washing process loop may range from 1.5 ppb to 12 ppb, though this is highly site specific.[30]

Potential pathways for acrylamide to enter the environment exist where:

1) water that has been treated with polyacrylamide is permitted to infiltrate into the ground,
2) fine materials removed during the clarifying process are stored and water infiltrates into the ground, or
3) water is unintentionally discharged from ponds to the ground or to streams.

Acrylamide readily breaks down in soil and water, though degradation rates will vary depending on environmental conditions. Typically, acrylamide will degrade faster in environmental conditions where oxygen is present (aerobic conditions), such as surface water and soils. Degradation rates are typically slower in the absence of oxygen (anaerobic conditions), such as water-logged soils or groundwater, or at lower temperatures.[31] Depending on soil conditions, acrylamide concentrations may decrease by as much as 50% in the first 21-36 hours.[32] In aerobic soil conditions, the U.S. EPA has estimated 74% to 94% of acrylamide may breakdown in 14 days; 64% to 89% of acrylamide may breakdown in anaerobic, waterlogged soils in 14 days.[33]

Considering the highly degradable nature of acrylamide in soils and the low anticipated amount of acrylamide present in industrial sand processing water (not drinking water), it is possible that any acrylamide that may infiltrate soil or groundwater could be below permissible *drinking* water standards within a few days.[34] Providing for the distance between industrial sand mines and residential wells, average groundwater flow velocities, and absence of acrylamide detections in groundwater near industrial sand facilities, it is unlikely that acrylamide persists in the environment at levels that could be hazardous to human health.

Groundwater monitoring at industrial sand facilities may be conducted in the interest of public safety and to ease public concern. Water quality data collected before and after mining begins can establish baseline data to better understand pre-mine

---

[iv] The approximate concentration of residual acrylamide can be estimated if the polyacrylamide used is potable-grade. Residual acrylamide in non-potable grade polyacrylamide can be estimated, but has not been confirmed by manufacturer laboratory testing, so the exact amount is unknown.
[v] One part per billion is roughly equivalent to one drop of water in a 10,000 gallon swimming pool.
[vi] Water-soluble polymers may also be added to the water loop when belt presses are used to remove water from waste materials, potentially resulting in additional acrylamide impurities in the water loop.

conditions. Chippewa County has required monitoring of acrylamide for four mines since 2011. During this time, acrylamide has not been detected in groundwater samples from these mines. Additional monitoring for acrylamide or other water quality parameters may be required in some counties as part of local ordinances or reclamation monitoring (R. Walls, November 16, 2015, personal communication).

There have been at least four documented cases of accidental release of water and sediment from holding ponds at industrial sand mines in Wisconsin during the past four years.[35,36,37,38] These failures were attributed to structural failure of a pond or erosion-control feature. Adherence to regulation and proper engineering and maintenance techniques may have prevented these failures. This type of release may impact private property and may be temporarily detrimental to waterways and ecosystems, leading to release of sediment-laden water that may also contain additives from the washing process. Human health impacts of this type of release have not been specifically evaluated in Wisconsin. The extent of impact to human health is highly site specific and depends on whether personal property is impacted or if the release affects an individual's access to food or drinking water. Human health impacts at the community level are unlikely given the overall rarity of these occurrences throughout the history of the industry in Wisconsin, and the rarity of surface water being relied on for drinking throughout the region. Though these releases have been rare, holding pond design is a factor that can be considered by permitting authorities in an effort to eliminate potential hazards. Individuals most likely to experience impacts from unintentional releases are residents in proximity to an industrial sand facility.

Finally, it should be noted that there is ongoing research by the Wisconsin Geological and Natural History Survey evaluating site-specific differences in metals concentrations of sandstone units which are commonly exposed at industrial sand mines (J. Zambito, personal communication, Nov. 10, 2015). This research will help to provide a baseline dataset for better understanding the relationship between rock type, water quality, and industrial sand mining.

SUMMARY

Following analysis of the range of industry practices, review of published literature, and consultation with subject area experts, the HIA research team characterized the potential for health effects as a result of impacts by industrial sand operations on water resources in western Wisconsin.

WATER QUANTITY

Likelihood – Based on consultation with subject experts and anecdotal reports, the potential for health effects from impacts to groundwater quantity is **possible**. Industrial sand mining facilities that withdraw groundwater have the potential to impact surrounding wells and surface water features, but these impacts are highly site specific and localized.

Intensity – There are many variables that will determine the magnitude of health effects from impacts to an individual's drinking water supply well. If health effects do occur, the intensity is expected to be **low to high.**

Distribution – If health effects occur, they are most likely to occur to few individuals in the **adjacent** area. Not all individuals near industrial sand facilities will experience these effects, and it is possible that no health effects will occur.

Evidence – Evidence is **moderate** that impacts to a private water supply are possible.

WATER QUALITY

Likelihood – Health effects from impacts to groundwater quality are **unlikely.** In the case that water-soluble polymers are released to the groundwater, impurities are expected to readily degrade and would be significantly diluted by either surface water or fresh water before they could come in contact with drinking water users near industrial sand sites.

Intensity – The most commonly used water-soluble polymers are not associated with adverse health effects. The acrylamide monomer that may be present at low concentrations as an impurity in the water-soluble polymer polyacrylamide is likely to be degraded in soil or groundwater. Therefore, intensity of health effects is expected to be **low.**

Distribution – If health effects occur, they are most likely to occur to few individuals in the **adjacent** area. Not all individuals in an adjacent area will experience these effects, and it is likely that no health effects will occur.

Evidence – Evidence is **strong** that impacts to water quality are unlikely. Acrylamide has not been detected in groundwater near industrial sand mines in Minnesota or Wisconsin, and the evidence for the ability of acrylamide to readily biodegrade in the environment is strong.

	Likelihood of potential health effects	Intensity of potential health effects	Distribution of potential health effects	Evidence for likelihood of health effects	Notes
Groundwater quantity	Possible	Low to High	Adjacent	Moderate	Potential health effects are not unique to impacts from industrial sand facilities
Groundwater quality	Unlikely	Low	Adjacent	Strong	

Key to Effects Characterization[vii]

Likelihood: How likely is it that a given health effect will occur in association with industrial sand mining

Insufficient evidence – The likelihood of a health effect cannot be judged based on available evidence
Unlikely – It is not likely that health effects will occur
Possible – Health effects are plausible
Likely – Health effects are probable
Very Likely – Health effects are highly probable

Intensity: The magnitude of the potential positive or negative health effects associated with industrial sand mining

Insufficient evidence – Evidence is inadequate to judge the intensity of health effects
Low – There are likely to be no or minimal health effects
Medium – Health effects may be minor; negative effects would be non-disabling
High – Positive or negative health effects may be considerable

Distribution: the expected impact based on proximity to an industrial sand facility[viii]

Occupational – Health effects, if any, may be limited to employees of the facility
Adjacent – Health effects, if any, may be experienced by individuals very near to a facility
Surrounding – Health effects, if any, may be experienced by individuals in the same community as a facility
Regional – Health effects, if any, may be experienced by individuals in western Wisconsin

Quality of evidence for the likelihood of health effects

None – There is no available evidence
Weak – Evidence is primarily anecdotal, based on media stories or individual reports
Moderate – Evidence is based on expert opinion, reports from experts, academics, industry, government, and others
Strong – Evidence is based on published studies not specific to western Wisconsin
Very Strong – Evidence is based on published studies specific to western Wisconsin

[vii] It should be noted that effects characterization relies on both qualitative and quantitative data and methods. It is also based on the evidence available at the time that this assessment is completed. As new evidence becomes available, effect characterization may change.

[viii] This categorization doesn't imply that all individuals within the geographic area will experience health effects, only that if health effects occur, the geographic area identified is relevant.

RECOMMENDATIONS

Policy makers should seek to understand the specific impacts to water resources that are expected at proposed mines so they can better understand the range of potential health effects. For proposed or existing industrial sand facilities, this assessment recommends:

1. Development of a set of voluntary industry standards, such as those suggested by the Wisconsin Industrial Sand Association (WISA) Code of Conduct, which may help to promote thoughtful review, policy and project development, and positive relationships with community members. The WISA Code of Conduct promotes, among other things:
    a. Open dialog with stakeholders.
    b. Consideration of stakeholder perspectives and appropriate action to minimize community impacts of industrial sand operations.
    c. Design and operation of safe and environmentally sound industrial sand facilities.

    Examples of the WISA code and other sustainability principles are included in Appendix B.
2. Representation of local, tribal, or regional public health departments as part of local permitting or review process. This may help improve positive health outcomes and minimize negative health effects. Public health representatives can provide a "health lens" to permitting discussions and serve to promote and protect public health interests in this process.

The following recommendations and considerations may also reduce negative health impacts and promote positive health outcomes. These recommendations and considerations may not be applicable for all industrial sand facilities, but may be useful for decision makers considering industrial sand mine applications.

	Recommendations
Existing Facilities	**To minimize potential negative health effects, it is recommended that policymakers:** 1 Encourage adoption of standards, such as those suggested by the WISA Code of Conduct. 2 Request that each existing facility: • establish a contact point for residents to ask questions or lodge complaints, • develop action plans to ensure response to and resolution of complaints, • develop action plans in the event of water contamination • make water quality testing results available to the public to increase transparency • develop plans to address impacts, reasonably attributed to facility operation, to other water supply wells. This can promote positive community relationships and ease public concern.

	Recommendations
Proposed Facilities	**To minimize potential negative health effects, it is recommended that policymakers:** 1 Encourage adoption of standards, such as those suggested by the WISA Code of Conduct. 2 Request that processing facilities under consideration include designs to recycle process water. This design significantly reduces the amount of water needed and may reduce the likelihood of impact to neighboring wells. 3 During the proposal consideration phase, establish a public or joint public/private contact point for residents to ask questions or lodge complaints, and establish action plans to ensure quick response to and resolution of complaints. 4 Request water quality and water level baseline data to be collected from nearby existing wells, or monitoring wells if necessary. Monitoring of water quality and water level in these wells can establish baseline data, and ease concern of nearby well owners. Policy makers should note that new monitoring wells can serve as new potential pathways for groundwater contamination, and should be employed conservatively. 5 Request that facilities develop plans to address impacts, reasonably attributed to facility operation, to other water supply wells. In addition, water quality testing results should be made publically available. This can promote positive community relationships and transparency, and ease public concern.
	Considerations
Existing and Proposed	1 Groundwater modeling should be performed and made publically available where there is sufficient data to conclude that impacts on existing wells are potentially likely. This can promote positive community relationships and transparency, and ease public concern.[ix] 2 If polyacrylamide is used, request that potable-grade polyacrylamide is used, such that the residual acrylamide concentration in process water can be calculated.

[ix] Appropriate methods and considerations for groundwater modeling should follow recent technical procedures such as those described by Anderson, M., Woessner, W., & Hunt, R. (2015). *Applied groundwater modeling: Simulation of flow and advective transport* (2nd ed.). Elsevier Science.

[1] Prüss-Üstün, A., Kay, D., Fewtrell, L., & Bartram, J. (2004). Unsafe water, sanitation and hygiene. In M. Ezzati, A.D. Lopez, A. Rodgers, & C. Murray (Eds.), *Comparative quantification of health risks – global and regional burden of disease attributable to selected major risk factors volume 1* (1321-1352). Geneva: World Health Organization.
[2] Prüss-Üstün, A., Kay, D., Fewtrell, L., & Bartram, J. (2004). Unsafe water, sanitation and hygiene. In M. Ezzati, A.D. Lopez, A. Rodgers, & C. Murray (Eds.), *Comparative quantification of health risks – global and regional burden of disease attributable to selected major risk factors volume 1* (1321-1352). Geneva: World Health Organization.
[3] World Health Organization. (n.d.). *Policy Brief – Water, health and ecosystems: the linkages*. Retrieved from http://www.who.int/heli/risks/water/water/en/.
[4] Smail, B. (2014, October 7). *Mining and water in Wisconsin: Water use for non-metallic mining.* [PowerPoint slides]. SME Wisconsin Annual Conference Presentation, Eau Claire, Wisconsin. Retrieved from https://higherlogicdownload.s3.amazonaws.com/SMENET/1b517024-bb1c-4b2c-b742-0136ce7a009c/UploadedImages/TCjointConference/Robert%20Smail%20-%20Water%20Usage%20in%20Non-Metallic%20Mining.pdf.
[5] Smail, B. (2014, October 7). *Mining and water in Wisconsin: Water use for non-metallic mining.* [PowerPoint slides]. SME Wisconsin Annual Conference Presentation, Eau Claire, Wisconsin. Retrieved from https://higherlogicdownload.s3.amazonaws.com/SMENET/1b517024-bb1c-4b2c-b742-0136ce7a009c/UploadedImages/TCjointConference/Robert%20Smail%20-%20Water%20Usage%20in%20Non-Metallic%20Mining.pdf.
[6] Smail, B. (2014, October 7). *Mining and water in Wisconsin: Water use for non-metallic mining.* [PowerPoint slides]. SME Wisconsin Annual Conference Presentation, Eau Claire, Wisconsin. Retrieved from https://higherlogicdownload.s3.amazonaws.com/SMENET/1b517024-bb1c-4b2c-b742-0136ce7a009c/UploadedImages/TCjointConference/Robert%20Smail%20-%20Water%20Usage%20in%20Non-Metallic%20Mining.pdf.
[7] Parsen, M.J., and Gotkowitz, M.B. (2015). *Chippewa County groundwater study – interim report*. Retrieved from http://co.chippewa.wi.us/home/showdocument?id=7228.
[8] Wisconsin Department of Natural Resources. (n.d.). *Wisconsin water use 2014 expanded withdrawal summary*. Retrieved from http://dnr.wi.gov/topic/WaterUse/documents/WithdrawalReportDetail.pdf.
[9] Wisconsin Department of Natural Resources. (n.d.). *High capacity well*. Retrieved from http://dnr.wi.gov/topic/Wells/highCapacity.html.
[10] Department of Natural Resources Drinking Water System: High Capacity Wells. Available at http://prodoasext.dnr.wi.gov/inter1/hicap$.startup
[11] Wisconsin Department of Natural Resources. General permit to discharge under the Wisconsin Pollutant Discharge Elimination System, nonmetallic mining operations. Retrieved from http://dnr.wi.gov/topic/wastewater/documents/46515_permit.pdf.
[12] Wisconsin Department of Natural Resources. General permit to discharge under the Wisconsin Pollutant Discharge Elimination System, nonmetallic mining operations. Retrieved from http://dnr.wi.gov/topic/wastewater/documents/46515_permit.pdf.
[13] U.S. Environmental Protection Agency. (n.d.). *Acrylamide hazard summary*. Retrieved from http://www3.epa.gov/airtoxics/hlthef/acrylami.html.
[14] National Sanitation Foundation. (n.d.). *NSF fact sheet polyelectrolytes and NSF/ANSI Standard 60.* Retrieved from http://www.nsf.org/newsroom_pdf/NSFFactSheetPolyelectrolytes.pdf
[15] Minnesota Department of Health. (2014 August). *Acrylamide and drinking water*. Retrieved from www.health.state.mn.us/divs/eh/risk/guidance/gw/acrylainfo.pdf.
[16] Wisconsin Industrial Sand Association. (2013 June). *Water soluble polymers and industrial sand mining*. Retrieved from http://www.wisconsinsand.org/assets/Water-Soluble-Polymers-and-Industrial-Sand-Mining-final-5_31_13-.pdf.
[17] Wisconsin Industrial Sand Association. (2013 June). *Water soluble polymers and industrial sand mining*. Retrieved from http://www.wisconsinsand.org/assets/Water-Soluble-Polymers-and-Industrial-Sand-Mining-final-5_31_13-.pdf.
[18] University of Wisconsin Water Resources Institute. (n.d.). *Groundwater drawdown factsheet*. Retrieved from http://aqua.wisc.edu/publications/pdfs/GroundwaterDrawdown.pdf.
[19] Hoffman, M. (2013, April 3). Sparta farmer eyes sand mines as cause of well issues. *LaCrosse Tribune.* Retrieved from http://lacrossetribune.com/news/local/sparta-farmer-eyes-sand-mine-as-cause-of-well-issues/article_a3c483f4-9b4a-11e2-b27f-001a4bcf887a.html.
[20] Town of Howard Mining Agreement with EOG Resources. Retrieved from http://www.wisctowns.com/uploads/ckfiles/files/Town%20of%20Howard%20Developers%20Agreement.pdf
[21] Parsen, M.J., and Gotkowitz, M.B. (2013). *Managing Chippewa County's groundwater—today and tomorrow.* Wisconsin Geological and Natural History Survey Factsheet 07. Retrieved from http://www.co.chippewa.wi.us/home/showdocument?id=68.

[22] Parsen, M.J., and Gotkowitz, M.B. (2015). *Chippewa County groundwater study – interim report*. Retrieved from http://co.chippewa.wi.us/home/showdocument?id=7228.
[23] U.S. Environmental Protection Agency. (n.d.). *Acrylamide hazard summary*. Retrieved from http://www3.epa.gov/airtoxics/hlthef/acrylami.html.
[24] Minnesota Department of Health. (2014 August). *Acrylamide and drinking water*. Retrieved from www.health.state.mn.us/divs/eh/risk/guidance/gw/acrylainfo.pdf.
[25] Center for Disease Control. (2009, November). *Acrylamide factsheet.* Retrieved from http://www.cdc.gov/biomonitoring/pdf/Acrylamide_FactSheet.pdf.
[26] National Toxicology Program. (2005, February). *NTP-CERHR monograph on the potential human reproductive and developmental effects of acrylamide* (NIH Publication No. 05-4472). Retrieved from https://ntp.niehs.nih.gov/ntp/ohat/acrylamide/acrylamide_monograph.pdf.
[27] Minnesota Department of Health. (2014 August). *Acrylamide and drinking water*. Retrieved from www.health.state.mn.us/divs/eh/risk/guidance/gw/acrylainfo.pdf.
[28] Department of Health and Human Services. (2012, December). *Acrylamide* (CAS #79-06-1). Retrieved from http://www.atsdr.cdc.gov/ToxProfiles/tp203-c1-b.pdf.
[29] Wisconsin Industrial Sand Association. (2013 June). *Water soluble polymers and industrial sand mining*. Retrieved from http://www.wisconsinsand.org/assets/Water-Soluble-Polymers-and-Industrial-Sand-Mining-final-5_31_13-.pdf.
[30] Barr Engineering. (2013 October). *Environmental impacts of water treatment chemicals at industrial sand mines.* Retrieved from https://www.barr.com/download/331.
[31] U.S. Environmental Protection Agency. (1985). *Health and environmental effects profile for acrylamide* (Technical Report EPA/600/X-85/270). Springfield, VA: U.S. Department of Commerce.
[32] U.S. Environmental Protection Agency. (1985). *Health and environmental effects profile for acrylamide* (Technical Report EPA/600/X-85/270). Springfield, VA: U.S. Department of Commerce.
[33] U.S. Environmental Protection Agency. (1985). *Health and environmental effects profile for acrylamide* (Technical Report EPA/600/X-85/270). Springfield, VA: U.S. Department of Commerce.
[34] Wisconsin Industrial Sand Association. (2013 June). *Water soluble polymers and industrial sand mining*. Retrieved from http://www.wisconsinsand.org/assets/Water-Soluble-Polymers-and-Industrial-Sand-Mining-final-5_31_13-.pdf.
[35] Baran, M. (2012, May 18). Frac sand sediment spills into St. Croix River. *MPR News*. Retrieved from http://www.mprnews.org/story/2012/05/18/environment/frac-sand-sediment-saint-croix-spill.
[36] Herald Newsroom. (2014, September 9). Sand mine in Trempealeau County agrees to pay $60K on allegations it violated water pollution laws. *Pierce County Herald.* Retrieved from http://www.piercecountyherald.com/content/wisconsin-news-roundup-sand-mine-trempealeau-county-agrees-pay-60k-allegations-it-violated.
[37] Luhmann, S. (2013, July 10). DNR: Sand mines violated stormwater permits. *LaCrosse Tribune*. Retrieved from http://lacrossetribune.com/news/local/dnr-sand-mines-violated-stormwater-permits/article_1b7a400e-e912-11e2-b9c6-001a4bcf887a.html.
[38] Kremer, R. (2013, April 22). Trempealeau County frac sand site ignores DNR, sees massive runoff. *WPR News.* Retrieved from http://www.wpr.org/trempealeau-county-frac-sand-site-ignores-dnr-sees-massive-runoff.

SECTION 6: LAND RECLAMATION & LAND VALUE

CONNECTION BETWEEN LAND RECLAMATION, LAND VALUE & HEALTH

LAND RECLAMATION

Land reclamation refers to the restoration of land previously used but no longer needed for industrial sand mining. Land may be restored to a quasi-natural state or amended for people-friendly purposes, such as parks or recreational areas. Land reclamation and health are connected through several pathways. These pathways include the potential for exposure to health hazards as well as support for healthy behaviors (such as walking, bicycling, and recreation) that may improve individual physical, mental, or social well-being.

LAND VALUE

Land or property value can also be connected with health. Land that is used for ranching, farming, or recreation can provide individuals with employment and income, thereby supporting access to health care, healthy food, and recreational activities. For landowners who intend to sell their land, a high property value may provide additional buying power. Where property values decrease, however, associated health outcomes may include stress or decreased purchasing power.

FOCUS OF THIS SECTION

The topic of land use is both broad and complex. During the scoping process for this HIA, we selected two focus areas: industrial sand mine reclamation and potential impacts to property values from industrial sand facilities. However, there are additional environmental and human health impacts from the development of land for use by industrial sand facilities that are not discussed in this report, such as wildlife displacement, increased water runoff, erosion, or impacts to water ecosystems. The magnitude of these environmental impacts and the potential for associated health effects is highly site specific, and an in-depth assessment of these impacts is outside the scope of this HIA. However, policymakers should seek to understand potential site-specific health effects associated with changes in land use at proposed facilities.

EXISTING LOCAL CONDITIONS

Regulations and permitting - The landscape in western Wisconsin has undergone significant changes over the past 150 years; it has changed from being primarily undeveloped hilly terrain accompanied by dense forests, to modern row-crop and cranberry agriculture, dairy farms, and urban development. This region is presently dominated by a rural, agricultural landscape with small cities and towns, and a few larger urban areas. Within this region, industrial sand facilities are generally present in rural areas or near small towns. Some of the regulations that industrial sand facilities are subject to are overseen by county and township authorities. In some instances, villages have annexed mines and provide the regulatory framework. The regulatory framework among villages, towns, and counties varies across Wisconsin. Examples of different regulations that may be administered by local authorities include:

- land reclamation (post-mining land use as required in Ch. NR 135 Wis. Adm. Code *Nonmetallic Mining Reclamation*);
- shoreland zoning ordinances (requirements for development near rivers, streams and navigable lakes, ponds, or flowages);
- erosion control and storm water management;
- zoning;
- conditional-use permitting (conditions that a developer must meet if the intended use is different from the zoned use; not applicable in areas without zoning administration);
- erosion control and storm water management;
- town licensing (may specify conditional uses in a non-zoned area);
- developer's agreement; and
- road use agreement

Before mine development can begin, a conditional use permit (if applicable), reclamation permit, and financial assurance for reclamation must be approved by local authorities that oversee NR 135 *Nonmetallic Mining Reclamation* (county or town, depending on which authority has adopted the ordinance). Following public notice, public input for these permits may be collected through public hearings. Permits related to high capacity wells, air emissions, wastewater discharge and many other applicable regulations must also be sought from local and state authorities. It should be noted that WDNR has oversight of the Non Metallic Mining Program, though the Wisconsin Administrative Code distributes Regulatory Authority to counties and towns to enact the program. WDNR then audits each county or town to ensure the standards in the code are appropriately carried through by the regulatory authority. If a regulatory authority is found to not be compliant with NR 135, the WDNR has the authority to take the program over and revoke regulatory authority from the county or town. As of the end of 2015, this has not happened in Wisconsin. Additional information on the local and state regulatory framework is described in the WDNR report *Silica Sand Mining in Wisconsin*.[1]

> *"Land use decisions should be local but regulatory oversight should be left at the appropriate regulatory agency with the expertise to address the issue."*
> Mining industry employee, Trempealeau County (response to stakeholder scoping survey)

Reclamation – There are many different types of land uses for areas that may be developed for industrial sand mining. These include crops, vegetables, pasture, upland vegetation, and in some cases, limestone aggregate mining. Post-mining land uses may include agriculture, wildlife habitat, recreational areas, and other types of development. After industrial sand mining operations are completed, land is reclaimed to the use prescribed in the approved reclamation plan.

Toy and Daniels (1998) define reclamation as "the treatment of disturbed areas to create stable landforms and edaphic [soil] conditions to sustain predetermined land uses with minimal maintenance."[2] Land reclamation at industrial sand mines is a process that begins relatively early in the mine life. Most industrial sand mines are divided into "cells" that are developed individually. Therefore, only small areas of a typical mine are actively excavated at any given time, and when excavation is complete in a given cell, reclamation of that area will begin while excavation of another cell is underway. This ongoing reclamation is required by NR 135, and is not precluded by mine size.

Reclamation strategies vary by site and the strategies used depend on both the land use prior to mine development and the post-mining land use options. These strategies are described in the reclamation plan prepared in accordance with NR 135. Advanced land reclamation techniques, described as 'geomorphic reclamation' or 'topographic reconstruction' have been successfully employed by at least one western Wisconsin industrial sand facility—Badger Mining Corporation. In this method, reclaimed land is reconstructed to mimic pre-mine topography, minimize erosion, and minimize post-reclamation maintenance.[3,4] This reclamation effort strives to restore the post-mining landscape more closely to its pre-mining appearance and improves soil and water retention by striving to achieve hydrologic equilibrium. In another example, two underground mines in Pierce County, Wisconsin, are currently being reclaimed as bat habitat. These mines serve as the state's second and third largest bat hibernation area, providing habitat for over 100,000 bats.[5,6]

Critical, scientific review of proposed reclamation plans by regulating authorities and public input can help eliminate potential exposure to human safety and health hazards that may exist at a mining operation following reclamation. Such potential hazards might include electrically-charged equipment, blasting agents, petroleum, oil, and other liquid chemicals; and physical hazards such as structures, equipment, and open excavations. Well-developed reclamation plans, properly implemented and maintained, generally result in successful reclamation and beneficial reuse of the land. A well-developed plan will thoroughly evaluate all potential pathways for impacts to human health and the environment and address ways to prevent negative health effects through these pathways. Long-term reclamation success may be measured by prevention of excessive water runoff, soil runoff, or damage to water ecosystems; and achievement of vegetative cover, vegetation diversity, wildlife establishment, and hydrologic response.[7,8]

NR 135 Wis. Admin. Code *Nonmetallic Mining Reclamation* establishes reclamation standards for, but is not limited to:
- Surface water and groundwater protection

- Habitat restoration and wetlands protection

- Topsoil, slope, and vegetation management

Reclamation activities at the Badger Mining Corporation facility near Taylor, WI. Courtesy: Badger Mining Corporation

POTENTIAL HEALTH IMPACTS

HOW WILL RECLAMATION OF INDUSTRIAL SAND MINES IMPACT HEALTH?

Different post-mine land uses have different effects on the environment and may contribute to different health effects for the end-user. For example, reclamation of a mine to a prairie or wooded area will have different impacts to soil structure, vegetation diversity, wildlife establishment, and groundwater recharge than reclamation to row-crops. Land that is reclaimed to natural areas such as prairie, oak savannah, wetland, or lakes may provide habitat for wildlife that are economically beneficial (e.g. important pest-controllers and pollinators such as bats, birds, and bees). In addition, though private property is developed for mining in western Wisconsin, this land may become accessible to the public following reclamation and subsequently used for recreation. Access to recreational areas can improve physical and mental health and well-being by promoting physical activity and relaxation.[9] Improved physical and mental health has been shown to decrease the occurrence of chronic diseases, increase lifespan, and promote healthy weight.[10] The degree of impact is dependent on land ownership prior to mine development, recreational alternatives available to the general public in the area of a recently developed mine, and the level of recreational use of the property prior to mine development. An example of public recreational use of reclaimed mine property is the Badger Mining Corporation sponsorship of the annual WDNR nine-day gun deer hunt for disabled persons, ongoing since 2001.[11]

All land uses have an impact on the environment. These impacts should be evaluated during review of reclamation plans in order to minimize negative human health effects. Reclaiming land so it can be used for heavy agriculture, such as row-crops, will have a different impact on soil, groundwater, and surface water, compared to land reclaimed for woodland or prairie. Regular tilling may compact the soil or lead to erosion. This can impact the amount of water able to infiltrate into the ground, or the amount of sediment in water ecosystems. Agricultural areas may be irrigated or undergo regular application of herbicides, pesticides, or nutrients (such as nitrogen) that can infiltrate or run off to drainage areas, thereby potentially impacting waterways or private drinking wells if improperly managed. Similarly, use of reclaimed land for pasture will have different impacts on vegetation, soil, water quality, and water ecosystems compared other types of land use.

If reclamation plans are poorly designed or improperly implemented, features such as unstable sediment piles or steep bedrock walls could pose a human safety concern. Potential environmental implications of poorly designed or improperly implemented reclamation plans may include excessive water runoff, soil erosion, and an influx of sediment into nearby water ecosystems. Human health hazards have not been identified at mine sites that have been reclaimed in accordance with NR 135. Attention to reclamation processes and maintenance of reclaimed land can eliminate potential negative health, safety, or environmental impacts from the mine site. However, different post-mine land uses will have different potential impacts to the environment and to human health, and these variables should be considered when developing the reclamation plan. The individuals most impacted by reclamation are anticipated to be residents that live in proximity to an industrial sand facility. It is not anticipated that special population groups would be particularly vulnerable to reclamation-related health effects.

The majority of sand mines in Western Wisconsin are above ground. However, it should be noted that underground mine reclamation approaches differ from those used for surface mines. Underground mines may encompass hundreds of acres, be located more than 100 feet below ground, and lie beneath agricultural land, forests, and roads, with no noticeable impact on surface land use. That said, surface reclamation may be undertaken for the above ground processing or loading facilities associated with the underground mine.

HOW WILL RECLAMATION OF INDUSTRIAL SAND MINES IMPACT AGRICULTURE?

The literature regarding reclamation of industrial sand mines to agriculture is sparse. To date, there has been little research completed in Wisconsin regarding soil health following land reclamation from sand mining to agriculture. This may be due in part to the low number of industrial sand mines that have completed mining to the point of reclamation, or there may be no impetus to document reclamation practices in technical or other publications. Though some agricultural land has been developed for industrial sand mining in Wisconsin, many areas mined for silica sand were either not farmed or were unsuitable for farming due to steep topography or poor soils (H. Dolliver, personal communication, July 8, 2015).

In 2014, University of Wisconsin-River Falls researchers began a five-year study in Chippewa County to investigate impacts of mining reclamation on soil health, which can have implications for many different types of post-mine land use (not just agriculture). This study is being conducted in collaboration with Chippewa County

Land Conservation and Forest Management. As of the publication of this HIA report, no results of this study were available. The first annual report is expected to be published in March 2016.

Outside of Wisconsin, only a few studies have investigated impacts of sand mining and reclamation on crop yield. Daniels et al. (2003) studied crop performance in an area in Virginia reclaimed after mineral sands mining (a process slightly different from industrial sand mining). Three years after reclamation, corn and soybeans planted in the reclaimed area produced yields 73% and 97%, respectively, when compared to corn and soybeans planted in non-mined areas.[12]

Reclamation to agricultural use is not appropriate or necessarily desirable for all areas that are being developed for industrial sand mining. For areas that were productively farmed prior to mining, reclamation to agricultural land may be appropriate and has been demonstrated to be achievable in other parts of the US. For industrial sand mines in Wisconsin, topsoil excavated during mining may be stored during mine development along with other mined material not suitable for processing or marketing. Mechanical handling and storage of topsoil can negatively impact soil structure, organisms in the soil, and other factors that contribute to soil quality. Some mining companies mitigate these disturbances during reclamation by amending the soil and using specific tillage practices.[13] For example, at Badger Mining Company in Taylor, Wisconsin, organic material such as tree branches and stumps that are removed during mine excavation are composted and added into the topsoil to improve soil structure and chemical balance (M. Lehman, personal communication, October 23, 2015).

It should be noted that agriculture, especially row-crop production, is an intensive land use that also has environmental impacts when compared to less demanding uses such as pasture, woodland, or prairie. The human health impacts of agriculture as an end land use are also different from other land uses. Agricultural land provides income and employment for a landowner or renter, and may result in associated health benefits. In addition, property taxes on agricultural land are generally lower than taxes on other property classifications, because agricultural property is assessed at “use value” (the ability to produce farm income) rather than full market value.[14]

Regardless of the particular setting, the environmental and potential human health impacts of various end land use options should be carefully evaluated in the development and implementation of industrial sand mine reclamation. Landowners who lease agricultural land to industrial sand facilities are most likely to be impacted by reclamation of land to agricultural use. It is not anticipated that any special population groups would be particularly vulnerable.

HOW WILL INDUSTRIAL SAND MINING IMPACT LAND AND PROPERTY VALUE?

Landowners who lease or sell their land to an industrial sand facility will receive income in the form of lease payments, royalties, or sale price. Increased income is associated with better health, and if the landowner had minimal or no previous income, the transaction would provide increased access to basic services such as healthy food, housing, health care, and other necessities.[15,16] In addition, increase in individual income has been found to be associated with a small but significant increase in one's self-rated health.[17] If the landowner already had access to basic services, the transaction may offer a continuation of that ability, along with potential to enhance the individual's buying power.

Property adjacent to an industrial sand facility may increase, decrease, or show no change in value. Potential impacts to property valuation are highly site specific and dependent on a range of variables. Much of the information regarding the positive or negative impact of industrial sand mines on adjacent property land value in western Wisconsin is anecdotal, and the authors of this HIA are not aware of any comprehensive Wisconsin-based study on property values and industrial sand mines. One study conducted by a certified residential appraiser in the Maiden Rock area did not find evidence that the presence of the Maiden Rock underground industrial sand mine affected the real estate market in Maiden Rock.[18] However, this mine is below ground, largely not visible from the highway, and relies on product shipment by train, so the example may not be representative of impacts to adjacent property values in other parts of the state. Anecdotal evidence from western Wisconsin suggests the potential impact on land value in the vicinity of sand mines is mixed, as both property value increases and decreases have been reported.[19] Property value increases are plausible if, for example, land that was previously being used for production agriculture is leased (or sold) for mine development, because land is typically valued much higher for mineral rights than for agricultural use.

The literature does support that the introduction of "undesirable facilities" to a community may impact property values. These effects can in part be the result of anticipated human health risks for individuals living close to the facility. However, the magnitude of property value impacts is inconsistent in the literature.[20] A summary of empirical studies by Farber (1998) indicated that property values in the vicinity of *waste* facilities could be negatively influenced by proximity to the facility and were commonly correlated with distance. The study also indicated that introducing a facility, even when perceived to be undesirable, may have a *positive* impact on property values if it is a source of local employment. Similarly, Ready (2010) found that impacts to property values by landfills in Pennsylvania were dependent on distance from the facility to a property, but that some landfills had no impact on property values, regardless of distance.[21] Though none of these studies serve as a direct analogue for industrial sand facilities, they do indicate that facilities typically perceived as "undesirable" may not impact property values in the same way in all communities.

One of the confounding factors for property value impacts is that buyers and sellers may have different sensitivities to the perceived risks of a particular facility.[22]

Potential buyers that see mine development as undesirable will not be interested in purchasing a property near a mine or where mine development is anticipated. Some buyers may be less sensitive to proximity to a mine, though this ‘acceptable’ distance could range from adjacent to miles away from a mine or processing facility. However, there are certainly instances in which properties situated close to a mine are likely to be devalued as a result of their proximity to the mine, perceived health risks, traffic, sightlines, or other impacts attributable to the industrial sand facility. The literature indicates that the impact on property values can change over the lifespan of a facility, and that the way the facility is portrayed by the media or groups opposing the facility may affect an individual’s perception of the facility.[23,24]

Negative health effects from impacts to adjacent property value are possible, though these effects will be highly dependent upon individual circumstances. One scenario is that in which a landowner unable to afford basic needs attempts to sell property and is unable to receive full market value, resulting in decreased equity or purchasing power. More likely, however, are potential health effects from the stress that landowners may feel if they fear they may have difficulty selling their property, or if indeed they are unable to sell their property at all. Increased stress can lead to negative health outcomes and may manifest as feelings of anxiety, anger, or physical symptoms, such as high blood pressure.[25,26,27] There are reported instances of Wisconsin industrial sand mining companies making fair market or above fair market offers to purchase properties that are difficult to sell (R. Kosheshek, personal communication, November 10, 2015). Fair market value guarantees are present in some town or county agreements with industrial sand facilities, such as for the Town of Howard in Chippewa County.[28] Having this type of guarantee in place prior to mine construction can help reduce anxiety or stress for landowners who want to sell their property; it can also prevent negative health effects from lost property value. These arrangements can build positive relationships and ease public concern.

When considering the impacts of industrial sand mining on land value, policy makers should be aware of the potential for localized impacts to property values, the potential health effects of changes to land value, and emerging research on this topic.[i] Individuals most impacted by land value changes are anticipated to be residents who live in proximity to an industrial sand facility and wish to sell their property. It is not anticipated that special population groups would be particularly vulnerable.

SUMMARY

Following analysis of the available evidence, review of published literature, and consideration of expert opinion, the HIA research team characterized the potential for

[i] The research team acknowledges the 2006 assessment of property value impacts of a proposed Michigan mine conducted by G. Erickcek. However, neither this study nor the theoretical model included in it have been peer-reviewed or published. Our research has found that property-value impacts are highly site-specific and that the Erickcek study does not contribute to the understanding of the issue.

health effects as a result of impacts by industrial sand operations to land reclamation and land value.

LAND RECLAMATION

Likelihood – Based on the regulatory framework, consultation with industry representatives, and consultation with land conservation experts, health effects (positive or negative) from reclamation of industrial sand mines are **unlikely**. No community-level health effects from reclaimed industrial sand mines in Wisconsin have been identified, and reclamation plans implemented in accordance with NR 135 are likely to prevent health hazards at a mine site.

Intensity – The intensity of health effects from land reclamation are anticipated to be **low.** Expert opinion and current practices by some facilities indicate that land reclamation can be performed in a manner that minimizes environmental and health impacts.

Distribution – Though health effects are unlikely, if any health effects do occur, they are likely to take place among residents **adjacent** to mining operations.

Evidence – Evidence is **moderate** that industrial sand facilities are unlikely to impact health as a result of reclamation. The evidence is mostly based on expert opinion, media stories, and anecdotal reports.

LAND VALUE

Likelihood – Health effects from impacts to land value from an industrial sand facility are **possible.** The potential for health effects is highly site specific and depends on a range of factors. The most likely health effects due to impacts to land value are feelings of stress for landowners who want to sell their property, especially if they experience difficulty selling it. Any impacts to land value are expected to be localized, and not community-wide.

Intensity – The intensity of health effects from impacts to property value may be **low to high** as impacts to an individual's income (and related ability to obtain basic services) or an individual's feelings of stress will be variable, as will the impacts to an individual's property value.

Distribution – If health effects occur, they are most likely to occur in the area **adjacent** to an industrial sand facility.

Evidence – Evidence is **strong** that impacts to land value are possible. However, not all facilities will impact land value in the same way, and not all property owners near industrial sand facilities will experience health impacts in the same way.

	Likelihood of potential health effects	Intensity of potential health effects	Distribution of potential health effects	Evidence for likelihood of potential to impact health effects	Notes
Land reclamation	Unlikely	Low	Adjacent	Moderate	
Property value	Possible	Low to High	Adjacent	Strong	The distribution is anticipated to be in the adjacent area, but does *not* imply that *all* individuals in the area will experience these effects

Key to Effects Characterization[ii]

Likelihood: How likely is it that a given health effect will occur in association with industrial sand mining

Insufficient evidence – The likelihood of a health effect cannot be judged based on available evidence
Unlikely – It is not likely that health effects will occur
Possible – Health effects are plausible
Likely – Health effects are probable
Very Likely – Health effects are highly probable

Intensity: The magnitude of the potential positive or negative health effects associated with industrial sand mining

Insufficient evidence – Evidence is inadequate to judge the intensity of health effects
Low – There are likely to be no or minimal health effects
Medium – Health effects may be minor; negative effects would be non-disabling
High – Positive or negative health effects may be considerable

Distribution: the expected impact based on proximity to an industrial sand facility[iii]

Occupational – Health effects, if any, may be limited to employees of the facility
Adjacent – Health effects, if any, may be experienced by individuals very near to a facility
Surrounding – Health effects, if any, may be experienced by individuals in the same community as a facility
Regional – Health effects, if any, may be experienced by individuals in western Wisconsin

Quality of evidence for the likelihood of health effects

None – There is no available evidence
Weak – Evidence is primarily anecdotal, based on media stories or individual reports
Moderate – Evidence is based on expert opinion, reports from experts, academics, industry, government, and others
Strong – Evidence is based on published studies not specific to western Wisconsin
Very Strong – Evidence is based on published studies specific to western Wisconsin

---

[ii] It should be noted that effects characterization relies on both qualitative and quantitative data and methods. It is also based on the evidence available at the time that this assessment is completed. As new evidence becomes available, effect characterization may change.

[iii] This categorization doesn't imply that all individuals within the geographic area will experience health effects, only that if health effects occur, the geographic area identified is relevant.

RECOMMENDATIONS

Policy makers should seek to understand the specific impacts expected at proposed sand mines to better understand the range of potential health impacts. For proposed or existing industrial sand facilities, this assessment recommends:

1. Development of a set of voluntary industry standards, such as those suggested by the Wisconsin Industrial Sand Association (WISA) Code of Conduct, which may help to promote thoughtful review, policy and project development, and positive relationships with community members. The WISA Code of Conduct promotes, among other things:
    a. Open dialog with stakeholders.
    b. Consideration of stakeholder perspectives and appropriate action to minimize community impacts of industrial sand operations.
    c. Design and operation of safe and environmentally sound industrial sand facilities.

    Examples of the WISA code and other sustainability principles are included in Appendix B.
2. Representation from local, tribal, or regional public health departments as part of local permitting or review process. This may improve positive health outcomes and minimize negative health effects. Public health representatives can provide a "health lens" to permitting discussions and serve to promote and protect public health interests in this process.

The following recommendations and considerations may also reduce negative health impacts and promote positive health outcomes. These recommendations and considerations may not be applicable for all industrial sand facilities, but may be useful for decision makers who are considering industrial sand mine applications. Regarding reclamation, decision and policy makers should keep in mind that in cases where the reclaimed mine property will remain private property, input into mine reclamation should focus first on public safety, second on meeting state and local regulations, third on appearance and potential for nuisance, and lastly on the personal preferences of the local decision makers and the public.

	Recommendations
Existing Facilities	**To minimize potential negative health effects from land reclamation, it is recommended that policymakers:** 1 Encourage adoption of standards, such as those suggested by the WISA Code of Conduct. 2 Request that each existing facility: a. establish a contact point for residents to ask questions or lodge complaints, b. develop action plans to ensure response to and resolution of complaints.

	Recommendations
Proposed Facilities	**To minimize potential negative health effects from land reclamation, it is recommended that policymakers:** 1 Include local or regional health department representatives on applicable and permitting panels. Reviewers should consider potential health effects of the reclamation plan, including health effects of the proposed end land use(s). 2 Establish a public or joint public/private contact point for residents to ask questions, and establish action plans to ensure quick response to and resolution of complaints during the proposal consideration phase. 3 Support reclamation techniques, such as geomorphic reclamation, that aim to return post-mine landscape to the pre-mining appearance, promote soil and vegetative health, and improve water retention in the reclaimed area. 4 Support end land uses that create opportunities for healthy, active living, where feasible. **To minimize potential negative health effects from land value it is recommended that policymakers:** 1 Review the pros and cons of an industry guarantee to provide fair market value for neighboring property owners.

	Considerations
Proposed Facilities	**To minimize potential negative health effects from land value, policymakers may consider:** Establish a public or joint public/private contact point for residents to ask questions, and establish action plans to ensure quick response to and resolution of complaints during the proposal consideration phase.

[1] Wisconsin Department of Natural Resources. (2012). *Silica Sand Mining in Wisconsin.* Madison, WI.
[2] Toy, T.J., & Daniels, W.L. (1998). Reclamation of disturbed lands. In: R.A. Meyers (Ed.), Encyclopedia of environmental analysis and remediation. (pp. 4078-4101). New York, NY: Wiley.
[3] Toy, T.J., & Daniels, W.L. (1998). Reclamation of disturbed lands. In: R.A. Meyers (Ed.), Encyclopedia of environmental analysis and remediation. (pp. 4078-4101). New York, NY: Wiley.
[4] Badger Mining Corporation. (2014) *Annual Environmental Report*. Retrieved from http://dnr.wi.gov/topic/GreenTier/Participants/Reports/BadgerMining2014.pdf
[5] Fairmount Minerals. (2014). Bat protection efforts stepped up as White Nose threat grows. *Neighbors Newsletter 1*, 3.
[6] Fairmount Minerals. (2013). Bat night highlights conservation partnership. *Neighbors Newsletter*, 2.
[7] Toy, T.J., & Daniels, W.L. (1998). Reclamation of disturbed lands. In: R.A. Meyers (Ed.), Encyclopedia of environmental analysis and remediation. (pp. 4078-4101). New York, NY: Wiley.
[8] Wisconsin Administrative Code. *Nonmetallic Mining Reclamation* NR 135, 135.15
[9] Godbey, G. (2009). Outdoor recreation, health, and wellness: understanding and enhancing the relationship. *RFF Discussion Paper 9-21*. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1408694
[10] Blair, S., Kohl, H., Paffenbarger, R., Clark, D., Cooper, K., & Gibbons, M.D. (1989). Physical fitness and all-cause mortality: A prospective study of healthy men and women. *Journal of American Medical Association, 262(17)*, 2395-2401.
[11] Badger Mining Corporation Special Hunt. Retrieved from http://bmcspecialhunt.com/.
[12] Daniels, W., Schroeder, P., Nagle, S., Zelazny, L., & Alley, M. (2003). Reclamation of prime farmland following mineral sands mining in Virginia. *Mining Engineering*, 42-48.
[13] See for example Barr Engineering, (2011, November 10). Sparta Plant reclamation plan prepared for US Silica. Retrieved from http://www.co.monroe.wi.us/wp-content/uploads/2012/01/20111110153305.US-Silica-DraftReclamationPlan-20111110reduced.pdf
[14] Legislative Audit Bureau. (2010). *Use Value Assessment of Agricultural Land Letter Report*. Madison, WI. Retrieved from http://legis.wisconsin.gov/lab/reports/10-usevalueassessment_ltr.pdf.
[15] Ecob, R., & Smith, G.D. (1999). Income and health: What is the nature of the relationship? *Social Science & Medicine, 48*, 693-705.
[16] Sorlie, P.D., Backlund, E., & Keller, J.B. (1995). US mortality by economic, demographic, and social characteristics: The national longitudinal mortality study. *American J. of Public Health*, *85(7)*, 949-956
[17] Gunasekara, F.H.I., Blakely, T., & Carter, K. (2008). Paper from Population Health Congress: *Do income changes over time affect changes in self-rated health?* Brisbane, Australia.
[18] Richardson, P.W., & Ducklow, B.M. (2011, January 15). Comparative study of Maiden Rock markets. Submitted in *Response to Citizen Concerns* by Fairmount Santrol, January 17, 2011. Report is part of conditional use permit application on file with Pierce County Land Management Committee.
[19] Dir, A. (2014, March 30). Frac sand mines credited for rising, dropping property values. *Wisconsin Watch.* Retrieved from http://wisconsinwatch.org/2014/03/frac-sand-mines-credited-for-rising-dropping-property-values/.
[20] Schively, C. (2007). Understanding the NIMBY and LULU Phenomena: Reassessing our knowledge base and informing future research. *Journal of Planning Literature, 21(3)*, 255-266.
[21] Ready, R.C. (2010). Do landfills always depress nearby property values? *J. Real Estate Rsch*, *32*(3), 321-340
[22] Zeiss, C., & Atwater, J. (1989). Water facility impacts on residential property values. *Journal of Urban Planning and Development, 115 (2),* 64-80.
[23] McCluskey, J., & Rausser, G. (2003). Hazardous waste sites and housing appreciation rates. *Journal of Environmental Economics and Management, 45(2),* 166-176.
[24] McClelland G.H., Schulze, W.D., & Hurd, B. (1990). The effect of risk beliefs on property values: A case study of a hazardous waste site. *Risk analysis: an official publication of the Society for Risk Analysis, 10(4),* 485-497.
[25] World Health Organization European Centre for Environment and Health. (2011). *Burden of disease from environmental noise.* Bonn, Germany: WHO Regional Office for Europe.
[26] Babisch, W. (2005). Noise and health [Guest editorial]. *Env. Health Perspectives*, *113(1),* A14-A15.
[27] World Health Organization European Centre for Environment and Health. (2011). *Burden of disease from environmental noise.* Bonn, Germany: WHO Regional Office for Europe.
[28]Town of Howard Mining Agreement with EOG Resources. Retrieved from http://www.wisctowns.com/uploads/ckfiles/files/Town%20of%20Howard%20Developers%20Agreement.pdf

SECTION 7: QUALITY OF LIFE

CONNECTION BETWEEN QUALITY OF LIFE & HEALTH

Quality of life is an umbrella term that can refer to a variety of themes. The ways in which quality of life impacts individual health are variable among different individuals and may change over time. Individuals who perceive that they have a good quality of life are more likely to experience better health outcomes.

FOCUS OF THIS SECTION

Three quality of life themes are addressed in this health impact assessment: cultural heritage and sense of place; economics; and the environmental factors of traffic, light, and noise.

CULTURAL HERITAGE AND SENSE OF PLACE & HEALTH

Emotional, spiritual, or social connection to a place may be closely linked to an individual's sense of identity, nostalgia, or place.[1] The Dictionary of Urban Geography defines 'sense of place' as "the attitudes and feelings that individuals and groups hold vis-à-vis the geographical areas in which they live. It further commonly suggests intimate, personal and emotional relationship between self and place."[2] The idea of 'sense of place' goes beyond the *quality* of a place and focuses on an individual's *satisfaction with* and *personal connection to* a place. An individual's sense of place is influenced by many different factors, including socio-economic status, health, age, and built environment.[3] Measureable characteristics of this bond may include attitude or ingrained cultural stances, values, and environmental perception.[4] When individuals are strongly bonded to their surroundings, their sense of place can be disturbed by a perceived or realized threat to their environment, and negative perceptions of an individual's environment have been associated with poor health outcomes.[5]

ECONOMICS & HEALTH

The body of socioeconomic literature strongly supports a correlation between socioeconomic status, mortality, and morbidity. Individuals with lower income, education, and work skills suffer from higher disease and death rates.[6,7,8] Low community-level socioeconomic status has been found to be associated with infant and adult mortality, suicide, long-term illness, negative child health outcomes, chronic diseases, and other poor health outcomes.[9] Income provides the opportunity for an individual to have control over life circumstances such as access to housing, healthy diet, and appropriate medical care. It also contributes to differences in mental health outcomes, including reduced stress levels.[10] A secure, financially and emotionally rewarding job can lead to positive health benefits, such as improved social well-being, mental well-being, and life expectancy.[11,12]

Income inequality (the difference in an individual's income compared to others in the area) has been found to have adverse health impacts at the community level. It can break down social cohesion, increase crime rates, and impose a perceived lack of well-being, all of which can contribute to poor health outcomes.[13,14]

TRAFFIC, LIGHT, NOISE, & HEALTH

A wide range of factors can influence the potential health effects from traffic, including the type and frequency of vehicles, individual proximity to roadways, roadway design, and many others. Potential health effects could include nuisance noise and light. High traffic volume can increase the risk of injury. Increased traffic volume can also adversely impact air quality through the release of fine particulates from vehicle exhaust.

Ongoing exposures to light and noise can trigger a range of health effects, which may be partly dependent on magnitude, timing, duration, and personal tolerance. Annoyance or nuisance effects have been associated with noise levels in the range of 40-55 decibels, which is approximately the level of noise produced by light traffic. Noise levels of 40-60 decibels can adversely affect sleep.[15] Excessive light and noise can impact human health by disturbing sleep, relaxation, cognitive focus and memory in children, and by causing annoyance, can manifest in physical symptoms such as higher stress hormones or blood pressure, anger, and anxiety.[16,17,18] Generally, short, high frequency, intense, intermittent sounds have greater negative health effects than continuous, low frequency, low intensity, long sounds.[19]

EXISTING LOCAL CONDITIONS

CULTURAL HERITAGE & SENSE OF PLACE

Federally-recognized Ho-Chunk Nation Tribal trust lands are present in western Wisconsin (Fig. 1.2) and dispersed throughout this landscape are sites of archaeological and cultural significance to the Ho-Chunk Nation. The Nation's Tribal Historic Preservation Office maintains a database of these sites. Though Ho-Chunk Nation lands in Wisconsin are not developed for industrial sand mining, sand mines may be adjacent to Tribal lands or to private property on which Tribal members reside. State statutes direct the Wisconsin Department of Natural Resources, in cooperation with the Wisconsin Historical Society, to identify and protect any archaeological sites or other cultural resources recorded by the Historical Society that could be adversely impacted by permitting or other action by the WDNR.[20]

However, not all locations of importance to Ho-Chunk history, customs, and culture are registered with the Wisconsin Historical Society.

Non-Tribal residents of the region may also closely identify with historical and modern land uses for agriculture, livestock, fishing, hunting, and recreation. These industries are reminiscent of ancestral activities and as such, cultivate a sense of place or nostalgia. For residents in the region, preserving these historical attributes can be important for maintaining their sense of place.

ECONOMICS

The data in the Community Health Profile (Section 3) provide a basic overview of the economic picture for Level 1 partner communities. This economic overview also provides a context for assessing the potential economic importance of industrial sand mining in these communities. Unemployment rates for Eau Claire, Trempealeau, and Pierce counties are 5%, which is slightly below the statewide average. Currently, employment is dominated in these counties by jobs that are not directly or indirectly related to sand mining (Table 3.4). In the western region of Wisconsin, job growth has been relatively steady since 2001, well before the increase in industrial sand mining activity that the region experienced in the late 2000's.[21] The western region exhibits a generally stable job market and industrial sand employment in Eau Claire, Pierce, and Trempealeau counties accounts for less than 1% of all jobs.[22]

TRAFFIC, LIGHT, AND NOISE

Industrial sand facilities are primarily present in rural areas or near small towns. The road infrastructure in these areas is primarily county roads and two-lane highways. In addition to passenger vehicle traffic, truck traffic from transport of retail goods, agricultural products, and sand and gravel excavation may be present. The primary sources of light and noise would be major industry within an area (such as agriculture, retail goods, construction, and others), daily activity from passenger traffic, and regular operations of small businesses.

In areas where industries rely heavily on trucks to transport goods, state statutes and the Facility Development Manual from the Wisconsin Department of Transportation provide local governments with the tools to manage impacts to roads.[23] Road upkeep and maintenance agreements are a tool for local authorities to negotiate with industrial roadway users. Negotiations may include how wear and tear on roads will be financed and managed. These agreements can help ensure that a traffic-generating industry (e.g., industrial sand, construction, waste hauling, or others) provides compensation for road maintenance.[24]

POTENTIAL HEALTH IMPACTS

HOW WILL INDUSTRIAL SAND MINING IMPACT CULTURAL HERITAGE AND SENSE OF PLACE?

The development of a mine in a rural area can impact perceptions around cultural heritage preservation or sense of place for some individuals. Development of a mine or processing facility will change the landscape and may impact sight lines of nearby residents. In addition to affecting the landscape, rail or road traffic and noise associated with mining or processing operations can change the soundscape of an area. Similarly, lights associated with the construction and operation of an industrial sand mine can change the degree of sky darkness in rural areas. Many of these impacts may only last while the mine is in operation, but others may last for many years after a mine is closed. Even after reclamation activities are complete, establishment of mature vegetation in a reclaimed area may take decades. If substantial water drawdown occurs in an area, this may affect wetlands that attract wildlife or streams used for fishing. Within the western region, there are individuals that strongly identify with and rely on hunting and gathering activities. Although the potential environmental impacts of mines may not have direct health effects, they may locally impact these lifestyles and traditions. Any or all of these changes can disrupt an individual's sense of place or cause discomfort because they alter "how things used to be." These types of changes may be perceived as a threat to an individual's environment and a loss of the familiarity, history, or meaning of a place for an individual. Researchers have coined the term "solastalgia" to describe this phenomenon: "pain or distress caused by the loss of, or inability to derive, solace connected to the negatively perceived state of one's home environment".[25] Concern for these types of changes even prior to the development of a mine can cause anxiety and mental stress that may range from minor to severe in different individuals.[26]

Though industrial sand mining and processing occurs in 13 of the 14 counties included in this assessment, it is not currently permitted on Ho-Chunk Nation lands within these counties. Industrial sand mining activity may conflict with cultural views about land use and tradition. Natural resources such as water and white sand, as well as specific areas used for ceremonies, hold special significance to Nation members. In order to better understand the cultural conflicts with industrial sand mining in the Ho-Chunk Nation, the HIA research team conducted key informant interviews with Tribal members in western Wisconsin. The following quotations illustrate the interviewees' sentiments regarding industrial sand mining and cultural heritage:

> *"This goes against our beliefs culturally…We have to live more in harmony and sand mining disrupts this harmony." (Monroe County resident, Ho-Chunk Nation member)*

> *"The land is given to us by our Creator, we are supposed to be stewards of it. They [sand mines] are disturbing [the] natural*

process of the earth." (Jackson County resident, Ho-Chunk Nation member)

"Our role is to take care of Mother Earth. We've always been taught every layer of earth is holy…the white sand itself is holy to us, it is used in our ceremony." (Juneau County resident, Ho-Chunk Nation member)

"All of our ceremonials are held at Grandma's property. We will be hearing trucks when we should be enjoying nature." (Eau Claire County resident, Ho-Chunk Nation member, on proposed industrial sand mine in Eau Claire County)

It is critical to note that impacts to human health from disturbance of cultural heritage or sense of place will be highly variable among individuals exposed to a similar situation and may vary based on timing, location, facility size, individual proximity to the site, extent of visible changes to the landscape, and other factors. Some individuals may feel little to no effects from changes to their environment and may not perceive these changes as threats. Other individuals may feel substantial effects such as high levels of stress or a negative perception of their environment, which in turn may be associated with anxiety or depression.[27,28] In addition to the psychological effects of stress, stress may be associated with physical and behavioral conditions such as high blood pressure, poor immune response, gastrointestinal conditions, sleep disturbances, and other conditions.[29]

"Road use issues are a large concern in some communities. This issue covers many facets." Mining industry representative, Trempealeau County (Response to stakeholder scoping survey)

The degree of control that individuals feel they have over a perceived or realized threat may impact the stress levels associated with the change, as lower perceived control over the environmental change is correlated with higher levels of stress.[30] Therefore, the ability for community members to have input into the permitting process or have open dialogue with current mine operators on facets that may impact an individual's quality of life (e.g., traffic, light, noise, sightlines, proximity to adjacent properties, or cultural and historical areas) may improve the perceived control a community feels over a change to their environment. Some facilities have (in addition to other mitigation techniques) constructed berms to block sight of and noise from a mine, minimized mine traffic by loading directly to rail from processing facilities, and limited operation and blasting hours to avoid negative noise and light impacts. The opportunity for local residents to provide comment during the permitting process could allow some residents to feel a greater level of control over a change to their surroundings, thereby potentially decreasing adverse health impacts.[31]

HOW WILL INDUSTRIAL SAND MINING IMPACT ECONOMICS AND HEALTH?

It is outside the scope of this HIA to provide an economic analysis of the industrial sand mining industry. Rather, this assessment addresses health effects as they relate to the potential economic impacts of industrial sand mines. Similar to agriculture and other market-based industries, the economic impact of industrial sand mining in Wisconsin is difficult to quantify, as market fluctuations can drastically change industry outlook—for better or worse—over a short period of time. The mining industry is historically cyclical, and individuals who directly or indirectly rely on industrial sand mines for income will likely experience economic impacts due to market fluctuations. When determining the impact to individuals, potential variables may include: whether they experience direct employment, indirect employment, or no employment gains, or whether they are affiliated with a business that could be impacted (positively or negatively) by an industrial sand facility.

The Wisconsin Economic Development Corporation has estimated the number of sustainable jobs from the industrial sand sector at between 2,500 and 3,000 statewide.[32] Other sources have estimated as many as 7,100 jobs would be directly supported if all permitted industrial sand mines and processing were fully operational.[33] The industrial sand industry has created jobs through direct employment and indirect employment in industries such as construction, transportation, and manufacturing. In some areas, these jobs may be significantly above the average pay in a given community.[34] The average earnings for quarry and mine employees (not exclusively industrial sand mining) in Eau Claire, Peirce, and Trempealeau counties is over $77,000.[35] This is approximately $18,000 - $30,000 higher than the median household income for these communities.[36] Industrial sand facilities may also contribute to tax revenue and economic diversification for the western region.[37,38]

"Jobs associated with sand mining are an important way of diversifying the economy in areas dominated by agriculture." University professor, Eau Claire County (response to stakeholder scoping survey)

In addition to economic benefits, there are also economic costs to industrial sand mining. Some industrial sand facilities are not able to employ all workers year-round, and market downturns have resulted in lost jobs. During this assessment period (2014-2015), a downturn in the global oil market led to less oil drilling and a reduced demand for industrial sand, leading to layoffs for multiple silica sand facilities in Wisconsin.[39] As discussed previously in this section, loss of income can create stress and anxiety in unemployed workers and extended unemployment may lead to financial burden. There is also evidence from the Blair-Taylor school district (Trempealeau and Jackson counties) that the introduction of a sand mine increased property values to the point that formula-based financial aid from the state was reduced.[40] Though industrial sand mining has provided employment opportunities and economic benefits, researchers agree that only a small percentage of total jobs in the region will be within the industrial sand industry, and that thus far, the industry has not proved to be a source of economic vitality.[41,42,43] Therefore, it is unlikely that economic cycles within the industry will have a significant impact on community-level economic stability.

HOW WILL INDUSTRIAL SAND MINING IMPACT TRAFFIC, LIGHT, AND NOISE EMISSIONS, AND COMMUNITY HEALTH?

TRAFFIC

Some citizens in the vicinity of industrial sand mines have expressed concern that taxpayers will be responsible for the financial burden of potential road degradation resulting from industrial sand mine truck traffic.[44] Indeed, industrial sand trucks will increase the number of vehicles on roads that may have been constructed for lighter or less frequent use, such as the roadways in areas previously zoned for agricultural use.[45] However, not all industrial sand mines rely on trucks for raw or processed product transportation to the same degree. Shipment of industrial sand by rail is less expensive than shipment by truck, and many mines primarily (or exclusively) ship via rail for this reason.[46] Once again, this underscores the need to look at potential health impacts on a site-by-site basis or to seek clarity in the case of pending plans and permits.

Since the actual impact of a particular industrial sand facility on traffic levels will be site-specific and highly variable, only the *potential* health impacts of industrial sand mine traffic can be assessed. Health impacts from vehicle traffic are dependent on the timing of traffic, vehicle type, number of vehicles or trucks, road surface, and other factors. Increased road traffic may increase the potential for crashes and injuries, air emissions, degradation of road conditions, or nuisance noise and light. Health effects of these impacts may include a threat to physical safety, air quality, or a perceived threat to an individual's environment if residents experience intolerable increases in noise or light from traffic. To better determine potential adverse health impacts, local authorities need to evaluate the increase in traffic from an industrial sand mine relative to pre-mining and existing seasonal traffic patterns, on a site-specific basis. Potential health effects to individuals could be minimized if facilities use measures that minimize vehicle traffic, such as direct-to-rail loading and transport, transport routes that minimize local residents' exposure to facility traffic, or other measures.

> *"Town residents like the quality of the farm community, but also like what the local mine does for the community."* Pierce County resident (response to stakeholder scoping survey)

In a recent study conducted in Chippewa County by the National Center for Freight & Infrastructure Research & Education, researchers evaluated the use of road upgrade and maintenance agreements.[47] This study found that these agreements have proven useful for industry and local authorities, but that more tools and guidance are needed for negotiating road use agreements that span multiple jurisdictions (e.g. county, town, and state). Using well-negotiated road upkeep and maintenance agreements with industrial sand facilities may prevent potential negative economic impacts to taxpayers who live near truck routes.

LIGHT AND NOISE

Light and noise impacts from industrial sand facilities are highly variable. These types of impacts depend on the location, size of the facility, season, blasting (if any), where and when excavation and processing occur, distance to adjacent property owners, and many other factors. Sources of noise from industrial sand operations may include vehicle traffic, train traffic, blasting, processing (crushing, washing, and drying), and on-site heavy machinery. Sources of light may include traffic, machinery, or ground-illuminating lights, if mining or processing occurs at night. Health effects from light and noise on an individual scale may range from imperceptible to significant and will vary according to the intensity and frequency of disturbances as well as individual sensitivity to them. Light and noise emissions from industrial sand facilities in the region are most likely to cause health effects from annoyance or nuisance exposure. These types of impacts can be mitigated through facility design, such as berms, ridges, or trees that can block noise and sound for nearby residents. Some facilities have limited the noise impacts to the immediate area by installing non-traditional heavy machinery back-up alarms that are less likely to be heard away from the mine site (T. Lindblad, personal communication, May 6, 2015). Policy makers should seek to understand the specific light, noise, and traffic expected at proposed sand mines and solicit public input, so they can better understand the range of potential health impacts.

SUMMARY

Following analysis of the range of industry practices, review of published literature, and consultation with subject area experts, the HIA research team characterized the potential for health effects as a result of impacts by industrial sand operations to the following aspects of quality of life:

CULTURAL HERITAGE & SENSE OF PLACE

Likelihood – Based on survey results, in-person interviews with community members, and a review of relevant literature, health effects from the impact of industrial sand mining on cultural heritage or sense of place are **likely.** This finding does not imply that these effects will be widespread, but *some* individuals are likely to experience health effects.

Intensity – There are many variables that will impact an individual's feelings of disturbance of sense of place or cultural heritage. As a result, the intensity of these effects is anticipated to range from **low to high.**

Distribution – The population most likely to experience health effects are those in the **surrounding** community.

Evidence – Evidence is **strong** that health effects are likely, should an individual experience a disruption to his or her sense of place or cultural heritage.

ECONOMIC

Likelihood –Economic impacts from industrial sand mining are **likely**. Impacts may be positive or negative and will be highly dependent on the community, facility, and individual. The direction of economic impacts may change over time.

Intensity – The intensity of health effects may range from **low to high** as there are many variables that factor into this measure. In addition, the intensity of economic impacts and subsequent health effects may change over time.

Distribution – Economic impacts from industrial sand mining may impact individuals in the **surrounding** area, though this does not imply that *every* individual will experience impacts, or the same intensity of impacts. Regional impacts may result from direct or indirect employment (especially transportation and construction), economic diversification, and others.

Evidence – Evidence is **strong** that economic impacts are possible in western Wisconsin.

TRAFFIC, LIGHT, & NOISE

Likelihood – Health effects from traffic, light, and noise are **possible**, though they will be highly dependent on the proximity of residents to industrial sand facilities, facility design, and other factors.

Intensity – The intensity of health effects from exposure to traffic, light, and noise may be **low to high,** as individual sensitivity to identical exposure can be highly variable.

Distribution – If health effects occur, they are most likely to occur in the **surrounding** area of an industrial sand facility.

Evidence – The evidence for potential health effects as a result of traffic, light, and noise exposure is **strong.** However, not all facilities will impact traffic, light, and noise in the same way.

	Likelihood of potential health effects	Intensity of potential health effects	Distribution of potential health effects	Evidence for likelihood of health effects	Notes
Cultural Heritage & Sense of Place	Likely	Low to high	Surrounding	Strong	Though effects are 'likely' for some individuals, this does not imply that *all* individuals will experience these effects.
Economic	Likely	Low to high	Surrounding	Strong	
Traffic, Light, Noise	Possible	Low to high	Surrounding	Strong	Potential health effects are not unique to impacts from industrial sand facilities.

Key to Effects Characterization[i]

Likelihood: How likely is it that a given health effect will occur in association with industrial sand mining

Insufficient evidence – The likelihood of a health effect cannot be judged based on available evidence
Unlikely – It is not likely that health effects will occur
Possible – Health effects are plausible
Likely – Health effects are probable
Very Likely – Health effects are highly probable

Intensity: The magnitude of the potential positive or negative health effects associated with industrial sand mining

Insufficient evidence – Evidence is inadequate to judge the intensity of health effects
Low – There are likely to be no or minimal health effects
Medium – Health effects may be minor; negative effects would be non-disabling
High – Positive or negative health effects may be considerable

Distribution: the expected impact based on proximity to an industrial sand facility[ii]

Occupational – Health effects, if any, may be limited to employees of the facility
Adjacent – Health effects, if any, may be experienced by individuals very near to a facility
Surrounding – Health effects, if any, may be experienced by individuals in the same community as a facility
Regional – Health effects, if any, may be experienced by individuals in western Wisconsin

Quality of evidence for the likelihood of health effects

None – There is no available evidence
Weak – Evidence is primarily anecdotal, based on media stories or individual reports
Moderate – Evidence is based on expert opinion, reports from experts, academics, industry, government, and others
Strong – Evidence is based on published studies not specific to western Wisconsin
Very Strong – Evidence is based on published studies specific to western Wisconsin

---

[i] It should be noted that effects characterization relies on both qualitative and quantitative data and methods. It is also based on the evidence available at the time that this assessment is completed. As new evidence becomes available, effect characterization may change.

ii This categorization doesn't imply that all individuals within the geographic area will experience health effects, only that if health effects occur, the geographic area identified is relevant.

RECOMMENDATIONS

Policy makers should seek to understand the specific sense of place; economic; and light, noise, and traffic impacts expected at proposed sand mines to better understand the range of potential health effects. For proposed or existing industrial sand facilities, this assessment recommends:

1 Development of a set of voluntary industry standards, such as those suggested by the Wisconsin Industrial Sand Association (WISA) Code of Conduct, which may help to promote thoughtful review, policy and project development, and positive relationships with community members. The WISA Code of Conduct promotes, among other things:
   a. Open dialog with stakeholders.
   b. Consideration of stakeholder perspectives and appropriate action to minimize community impacts of industrial sand operations.
   c. Design and operation of safe and environmentally sound industrial sand facilities.

   Examples of the WISA code and other sustainability principles are included in Appendix B.

2 Representation from local, tribal, or regional public health departments as part of the local permitting or review process. This may improve positive health outcomes and minimize negative health effects. Public health representatives can provide a "health lens" to permitting discussions and serve to promote and protect public health interests in this process.

The following recommendations and considerations could reduce negative health impacts and promote positive health outcomes. These recommendations and considerations may not be applicable for all industrial sand facilities, but may be useful for decision makers who are considering industrial sand mine applications.

	Recommendations
Existing Facilities	**To minimize potential negative health effects from impacts, it is recommended that policymakers:** **Cultural Heritage and Sense of Place** 1 Request that each existing facility establish a contact point for residents to ask questions, and develop action plans to ensure response to and resolution of complaints. 2 Request that facilities strive for minimizing impacts to sense of place by listening to and considering stakeholder perspectives for sense of place issues important to the surrounding community. 3 Support efforts to develop constructive relationships between mining companies and Indigenous Peoples, including suggestions in the ICMM *Indigenous Peoples and Mining Position Statement.*[48]

	Recommendations
Existing Facilities	**Traffic, Light, and Noise:** 1 Be familiar with how to assess roadway impacts from truck traffic and establish a process for mitigating impacts from high-volume industries in accordance with state statutes. 2 Promote full consideration of stakeholder perspectives related to noise, light, or other tangible impacts from industrial sand mines. 3 Request that each existing facility establish a contact point for residents to ask questions, and develop action plans to ensure response to and resolution of complaints.
Proposed Facilities	**To minimize potential negative health effects from impacts, it is recommended that policymakers:** **Cultural Heritage and Sense of Place** 1 During the proposal consideration phase, establish a public or joint public/private contact point for residents to ask questions, and develop action plans for response. 2 Encourage facility design that minimizes impacts to the soundscape and sightlines of nearby residents. 3 Consult with Tribal Historical Preservation Office to evaluate the potential for impact to cultural or archeological sites. **Economics:** Evaluate and consider all potential positive and negative economic impacts of a proposed industrial sand facility during the permitting process. **Traffic:** 1 Be familiar with how to assess roadway impacts from truck traffic and establish a process for mitigating impacts from high-volume industries in accordance with state statutes. 2 Encourage facility design plans that include provisions to minimize the impact of sand transport, such as direct-to-rail shipment. **Traffic, Light, and Noise:** 1 During the proposal consideration phase, be sure to fully consider all stakeholder perspectives related to noise, light, and other tangible impacts from industrial sand mines. 2 During the proposal consideration phase, establish a public or joint public/private contact point for residents to ask questions, and establish action plans for response to and resolution of complaints.
	Considerations
Proposed Facilities	**To minimize potential negative health effects from economic impacts, policy makers may consider:** Encourage sustainable business models that work to minimize impacts to mine employees during seasonal or market fluctuations.

[1] Hawke, S. (2012). Heritage and sense of place: Amplifying local voice and co-constructing meaning. In I. Convery, G. Corsane, & P. Davis (Eds.), *Making sense of place – Multidisciplinary Perspectives* (pp. 235-246). Woodbridge, UK: Boydell Press.
[2] Wylie, J. (2009). Sense of place. In D. Gregory, R. Johnston, G. Pratt, M. J. Watts, & S. Whatmore (Eds.), *The dictionary of human geography* (5th ed.). Chichester, UK: Wiley-Blackwell.
[3] Williams, A., & Kitchen, P. (2012). Sense of place and health in Hamilton, Ontario: A case study. *Social Indicators Research*, *108*(2), 257–276.
[4] Ogunseitan, O.A. (2005). Topophilia and the quality of life. *Environmental Health Perspectives*, *113*(2), 143-148.
[5] Williams, A., & Kitchen, P. (2012). Sense of place and health in Hamilton, Ontario: A case study. *Social Indicators Research*, *108*(2), 257–276.
[6] Feinstein, J.S. (1993). The relationship between socioeconomic status and health: A review of the literature. *The Milbank Quarterly*, *71*(2), 279-322.
[7] Feinstein, J.S. (1993). The relationship between socioeconomic status and health: A review of the literature. *The Milbank Quarterly*, *71*(2), 279-322.
[8] Sorlie, P.D., Backlund, E., & Keller, J.B. (1995). US mortality by economic, demographic, and social characteristics: The national longitudinal mortality study. *American Journal of Public Health*, *85*(7), 949-956.
[9] Yen, I.H, & Syme, S.L. (1999). The social environment and health: A discussion of the epidemiologic literature. *Annual Review of Public Health*, *20*, 287-308.
[10] Kosteniuk, J., & Dickinson, H. (2003). Tracing the social gradient in the health of Canadians: Primary and secondary determinants. *Social Science & Medicine*, *57*(2), 263-276.
[11] World Health Organization. (2000). *Mental health and work: Impact, issues and good practices.* Geneva, Switzerland: G. Harnois & P. Gabriel.
[12] The Work Foundation and London Health Commission. (2005). *Healthy work: productive workplaces.* England: D. Coats & C. Max.
[13] Wilkinson, R.G. (1996). *Unhealthy societies: The afflictions of inequality*. London: Routledge.
[14] Yen, I.H, & Syme, S.L. (1999). The social environment and health: A discussion of the epidemiologic literature. *Annual Review of Public Health*, *20*, 287-308.
[15] London Health Commission. (2003). *Noise and health: Making the link*. Retrieved from http://hiaconnect.edu.au/old/files/Noise_and_Health.pdf.
[16] World Health Organization. (2011). *Burden of disease from environmental noise*. Bonn, Germany: F. Theakston (ed.).
[17] Babisch, W. (2005, January). Noise and health [Guest Editorial]. *Environmental Health Perspectives*, *113*(1), A14-A15.
[18] World Health Organization. (2011). *Burden of disease from environmental noise*. Bonn, Germany: F. Theakston (ed.).
[19] London Health Commission. (2003). *Noise and health: Making the link*. Retrieved from http://hiaconnect.edu.au/old/files/Noise_and_Health.pdf.
[20] Wisconsin Department of Natural Resources. (2012). *Silica Sand Mining in Wisconsin.* Madison, WI.
[21] West Central Wisconsin Regional Planning Commission. (2015). 2nd *quarter quarterly census of employment and wages, Eau Claire County, Trempealeau County, Pierce County.*
[22] West Central Wisconsin Regional Planning Commission. (2015). 2nd *quarter quarterly census of employment and wages, Eau Claire County, Trempealeau County, Pierce County.*
[23] Stelzner, B. (2011, December). Frac sand mining—Local government roadway impacts. Retrieved from http://www.tdawisconsin.org/data/publications/wtda-sand-mine-article-dec-2011.pdf.
[24] Stelzner, B. (2011, December). Frac sand mining—Local government roadway impacts. Retrieved from http://www.tdawisconsin.org/data/publications/wtda-sand-mine-article-dec-2011.pdf.
[25] Albrecht, G., Sartore, G., Connor, L., Higginbotham, N., Freeman, S., Kelly, B., ... Pollard, G. (2007). Solastalgia: the distress caused by environmental change. *Australasian Psychiatry*, *15 Suppl.*, 95-98.
[26] Albrecht, G., Sartore, G., Connor, L., Higginbotham, N., Freeman, S., Kelly, B., ... Pollard, G. (2007). Solastalgia: the distress caused by environmental change. *Australasian Psychiatry*, *15 Suppl.*, 95-98.
[27] Albrecht, G., Sartore, G., Connor, L., Higginbotham, N., Freeman, S., Kelly, B., ... Pollard, G. (2007). Solastalgia: the distress caused by environmental change. *Australasian Psychiatry*, *15 Suppl.*, 95-98.
[28] Speldewinde, P.C., Cook, A., Davies, P., & Weinstein, P. (2009). A relationship between environmental degradation and mental health in rural Western Australia. *Health & Place*, *15*, 865-872.
[29] University of Maryland Medical Center. (2013) *Stress*. Retrieved from http://umm.edu/health/medical/reports/articles/stress.
[30] Evans, G.W., & Cohen, S. (1987). Environmental stress. In D. Stokols & I. Altman (Eds.), *Handbook of environmental psychology* (571-610). New York: Wiley
[31] Evans, G.W., & Cohen, S. (1987). Environmental stress. In D. Stokols & I. Altman (Eds.), *Handbook of environmental psychology* (571-610). New York: Wiley

[32] Prengaman, K. (2012, August 19). Frac sand boom creates thousands of jobs. Retrieved from http://wisconsinwatch.org/2012/08/sand-boom-creates-jobs/.
[33] Orr, I. & Krumenacher, M. (2015, May). *Economic impacts of industrial silica sand (frac sand) mining*. Retrieved from https://www.heartland.org/policy-documents/economic-impacts-industrial-silica-sand-frac-sand-mining.
[34] Power, T.M., & Power, D.S. (2013, May). *The Economic Benefits and Costs of Frac-Sand Mining in West Central Wisconsin*. Retrieved from http://www.iatp.org/files/2013_05_30_FracSandMining_f.pdf.
[35] West Central Wisconsin Regional Planning Commission, *2015 2nd Quarter Quarterly Census of Employment and Wages, Eau Claire County, Trempealeau County, Pierce County.*
[36] U.S. Census Bureau. United States quick facts, 2010-2014 income, in 2014 dollars. Available at http://quickfacts.census.gov/qfd/index.html.
[37] Prengaman, K. (2012, August 19). Frac sand boom creates thousands of jobs. Retrieved from http://wisconsinwatch.org/2012/08/sand-boom-creates-jobs/.
[38] Economic Modeling Specialist Inc. (2011). *The economic impact of frac sand mining: A look at jobs and earnings in Wood County, Wisconsin.* Moscow, ID: Robison, H., Nadreau, T., & Wright, J.
[39] Kremer, R. (2015, October 13). More layoffs announced in frac sand industry. *WPR News*. Retrieved from http://www.wpr.org/more-layoffs-announced-frac-sand-industry
[40] Kremer, R. (2013, August 28). Frac sand mine leaves nearby school districts with less state aid. *WPR News.* Retrieved from http://www.wpr.org/frac-sand-mines-leave-nearby-school-districts-less-state-aid.
[41] Power, T.M., & Power, D.S. (2013, May). *The economic benefits and costs of frac-sand mining in west central Wisconsin*. Retrieved from http://www.iatp.org/files/2013_05_30_FracSandMining_f.pdf.
[42] Orr, I. & Krumenacher, M. (2015, May). *Economic impacts of industrial silica sand (frac sand) mining*. Retrieved from https://www.heartland.org/policy-documents/economic-impacts-industrial-silica-sand-frac-sand-mining.
[43] Economic Modeling Specialist Inc. (2011). *The economic impact of frac sand mining: A look at jobs and earnings in Wood County, Wisconsin.* Moscow, ID: Robison, H., Nadreau, T., & Wright, J.
[44] Orr, I. & Krumenacher, M. (2015, September). *Roadway impacts of industrial silica sand (frac sand) mining*. Retrieved from https://www.heartland.org/policy-documents/roadway-impacts-industrial-silica-sand-frac-sand-mining.
[45] Stelzner, B. (2011, December). Frac sand mining—Local government roadway impacts. Retrieved from http://www.tdawisconsin.org/data/publications/wtda-sand-mine-article-dec-2011.pdf.
[46] Wisconsin Department of Natural Resources. (2012). *Silica Sand Mining in Wisconsin.* Madison, WI.
[47] Hart, Adams & Schwartz, http://midamericafreight.org/wp-content/uploads/FracSandWhitePaperDRAFT.pdf
[48] International Council on Mining and Metals. (2013). *Indigenous Peoples and Mining Position Statement.* Retrieved from https://www.icmm.com/publications/icmm-position-statement-on-indigenous-peoples-and-mining

CONCLUSION

It has been a privilege to work with the individuals and organizations that made this assessment possible. A special note of appreciation goes to Audrey Boerner MS, for her integrity and extraordinary effort.

The Institute for Wisconsin's Health hopes that this report will be a valuable and practical resource for local and tribal health departments and for policy makers in Wisconsin as they seek to promote the health and safety of the people in their jurisdictions.

We acknowledge the complexity of the issues examined in this report and welcome additional input moving forward.

Nancy Young

Executive Director

nyoung@instituteforwihealth.org

APPENDIX A: REGIONAL ASTHMA DATA

Table A.1 presents age-adjusted rates of asthma emergency department visits by county of interest in two-year periods from 2002 through 2013. The data on asthma emergency department visits are collected from emergency room discharge records and include all visits with an ICD-9 code of 493 in the principal diagnosis field. Data were grouped in two-year intervals to improve rate stability. Direct age-adjusted rates were calculated using the 2000 US standard population for Wisconsin. Table A.2 presents the results of a series of linear regressions that were conducted to assess the linearity of age-adjusted asthma rates over time by county of interest. For each county, two-year time categories were regressed on the age-adjusted rate to test if a linear trend (either increasing or decreasing) best fit the data. Fisher exact tests (F-tests) were used to test the statistical significance of the linear fit. The F-tests and accompanying p-values are also presented (Table A.2). Source data are available on the Wisconsin EPHT public data portal (dhs.wisconsin.gov/epht).

Table A.1. Two-year age-adjusted rates of asthma emergency department visits by county of interest

County	2002-2003	2004-2005	2006-2007	2008-2009	2010-2011	2012-2013
BARRON	24.5	30.8	32.3	34.5	33.5	32.9
BUFFALO	13.5	12.5	19.9	21.9	30.9	23.4
CHIPPEWA	36.6	36.2	26.7	29.7	21.5	13.6
CLARK	18.6	19.2	18.6	18.7	23.7	20.6
DUNN	26.6	26.7	29.2	28.4	21.9	21.4
EAU CLAIRE	30.9	24.3	27.9	30.6	25.0	22.3
JACKSON	61.2	57.5	37.1	34.3	33.7	31.2
LA CROSSE	21.9	22.8	20.4	21.3	21.0	16.7
MONROE	38.7	38.5	41.9	43.2	34.2	35.1
PEPIN	18.0	24.3	34.2	41.1	25.1	32.4
PIERCE	21.5	24.8	24.3	30.3	29.1	28.0
RUSK	39.8	47.4	34.5	27.7	36.9	34.9
ST. CROIX	21.0	25.1	22.7	24.4	20.2	20.6
TREMPEALEAU	26.3	24.9	23.0	21.8	22.1	15.1

Table A.2. Fisher exact test for linear regressions used to assess trends in age-adjusted asthma rates over time by county of interest

County	F-Value	P-Value	Direction of Trend
BARRON	5.9	0.072	Positive
BUFFALO	9.5	0.037*	Positive
CHIPPEWA	31.4	0.005*	Negative
CLARK	2.7	0.179	Positive
DUNN	3.3	0.145	Negative
EAU CLAIRE	2.0	0.232	Negative
JACKSON	18.3	0.013*	Negative
LA CROSSE	5.6	0.077	Negative
MONROE	1.0	0.372	Negative
PEPIN	1.5	0.287	Positive
PIERCE	8.2	0.046*	Positive
RUSK	1.4	0.299	Negative
ST. CROIX	0.7	0.438	Negative
TREMPEALEAU	17.9	0.013*	Negative
**statistically significant at p=<0.05*			

APPENDIX B: INDUSTRY RELATIONS EXAMPLES

WISCONSIN INDUSTRIAL SAND ASSOCIATION (WISA) CODE OF CONDUCT

GUIDING PRINCIPLES

To lead in ethical ways that benefit society, the environment and the economy – People, Planet and Prosperity;

To design and operate industrial sand facilities in a safe and environmentally sound manner;

To promote clean water and clean air, minimization of waste and conservation of energy and other critical resources in the mining and processing of industrial sand;

To collaborate with state and local governments in the state of Wisconsin in the development of effective, efficient and scientifically based safety, health, environmental and land use laws, regulations and standards;

To be a leader in education and research on the health, safety, and environmental effects of crystalline silica and industrial sand mining and processing operations;

To communicate with stakeholders and listen to and consider their perspectives – seek a "balance" between competing interests, consistent with People, Planet, Prosperity;

To make continual progress toward a goal of no accidents, injuries, occupational disease cases at or from industrial sand operations in the state of Wisconsin, and to openly report health and safety performance;

To work with carriers to foster the safe transport of industrial sand, to work with carriers and other stakeholders to minimize to the extent commercially feasible the impact of transporting sand;

To instill a culture throughout all levels of the member company organizations to continually advance these guiding principles.

PERFORMANCE STANDARDS

ENVIRONMENTAL:

WISA member shall be a participant in good standing in the Wisconsin DNR Green Tier Program, as a Tier 1 participant, for each of its industrial sand facilities within the state of Wisconsin. If a WISA member opens a new industrial sand facility in the state of Wisconsin, the WISA member shall apply for Tier 1 participation in the Wisconsin DNR Green Tier Program for that facility within 45 days of of that facility becoming operational, i.e., beginning to ship or sell industrial sand for commercial purposes.

Upon application for membership in WISA, the applicant shall not have any of the following:

Within 60 months, a judgment of conviction entered against it, any managing operator of it, or any person with a 25% or more ownership interest in the WISA member for a criminal violation of an environmental regulation.

Within 36 months a civil judgment entered in a Wisconsin Circuit Court or Wisconsin United States District Court against it, any managing operator of the applicant, or any person with a 25% or more ownership interest in it for a violation of an environmental regulation involving a covered facility that resulted in substantial harm to public health or the environment.

Within 36 months, the WISA member, any managing operator of the WISA member, or any person with a 25% or more ownership interest in the WISA member has been referred to the Wisconsin Department of Justice for enforcement of an environmental regulation involving a covered facility or activity that resulted in substantial harm to public health or the environment.

Within 24 months, the WISA member, any managing operator of the WISA member, or any person with a 25% or more ownership interest in the WISA member has been issued an environmental citation by the Wisconsin Department of Natural Resources involving a covered facility or activity that resulted in substantial harm to public health or the environment.

SAFETY:

Adopt the National Industrial Sand Association's (NISA) Silicosis Prevention Program and implement the NISA Occupational Health Program (OHP), which means that each member of WISA is required at a minimum to conduct dust monitoring for respirable crystalline silica and medical surveillance per the guidelines set forth in the NISA OHP (as it may be amended from time to time) in connection with their Wisconsin industrial sand facilities. Further, WISA members will report annually the results of medical surveillance and dust sampling at their Wisconsin industrial sand facilities to WISA.

Maintain an average respirable crystalline silica dust exposure level for each major job category, for each Wisconsin industrial sand facility, at or below .05 mg/m^3.

COMMUNITY

(Including land use, transportation, community outreach and emergency response initiatives):

Dialog with stakeholders, and action as appropriate, to minimize the community impacts of industrial sand operations, e.g., tangible efforts to reduce noise, light pollution, blasting impacts, visual impacts, impact of truck and rail traffic;

Establish a program to communicate relevant information concerning Wisconsin facilities to local communities;

Engage local communities to identify and promote local community education projects, e.g., facility open houses, tours;

Develop and manage wildlife habitat;

Engage the local community to identify and promote local environmental projects.

POST MINING LAND USE/RECLAMATION

Adopt reclamation plans to provide post-mining economic and/or environmental value to the affected communities; engage the stakeholders when appropriate in connection with reclamation and post-mining land use planning; maintain compliance with mining permit and reclamation plan.

MANAGEMENT

Chief Executive Officer (or equivalent) written commitment to Guiding Principles and Performance Standards;

With regard to the Performance Standards, submit a report annually to WISA by February 15 of each year, starting in 2014, describing the results for each Standard for the prior calendar year.

INTERNATIONAL COUNCIL ON MINING & METALS

10 PRINCIPLES OF THE SUSTAINABLE DEVELOPMENT FRAMEWORK

01. Implement and maintain ethical business practices and sound systems of corporate governance.

02. Integrate sustainable development considerations within the corporate decision-making process.

03. Uphold fundamental human rights and respect cultures, customs and values in dealings with employees and others who are affected by our activities.

04. Implement risk management strategies based on valid data and sound science.

05. Seek continual improvement of our health and safety performance.

06. Seek continual improvement of our environmental performance.

07. Contribute to conservation of biodiversity and integrated approaches to land use planning.

08. Facilitate and encourage responsible product design, use, re-use, recycling and disposal of our products.

09. Contribute to the social, economic and institutional development of the communities in which we operate.

10. Implement effective and transparent engagement, communication and independently verified reporting arrangements with our stakeholders.


INSTITUTE FOR
WISCONSIN'S HEALTH INC.

Midwest Environmental Advocates

June 5, 2016

Michael Ross
Wisconsin Department of Natural Resources
3550 Mormon Coulee Road
La Crosse, WI 54601

Re: Superior Silica Sands – Arland Plant, FID 603110860, Construction Permit No. 15-MHR-064, Operation Permit No. 603110860-P01

Dear Mr. Ross:

Midwest Environmental Advocates (MEA) and Environmental Integrity Project (EIP) respectfully submit these comments to the Wisconsin Department of Natural Resources (DNR). These comments examine DNR's proposal to issue the above air pollution control permits to Superior Silica Sands (SSS) - Arland Plant. We are concerned that the proposed permits fail to comply with the Clean Air Act, and authorize an increase in facility emissions without demonstrating compliance with ambient air standards.

Several of the issues with the proposed permit relate to DNR's new policy on permitting and regulating emissions of PM2.5,[1] collectively referred to as DNR's PM2.5 Guidance.[2] Both MEA and the U.S. Environmental Protection Agency (EPA) expressed our concerns with DNR's PM2.5 Guidance while it was under public review. (*See* Attachment A for EPA's comments.)

MEA's central concerns with DNR's PM2.5 Guidance, which were echoed by EPA, are that it allows DNR to issue air permits without including PM2.5 emission estimates or limits, and without conducting modeling for compliance with PM2.5 ambient air standards. For the reasons summarized below and detailed in attached documents, the proposed air permits are not in compliance with the Clean Air Act or Wisconsin's air pollution control laws.

[1] PM2.5 is shorthand for particulate matter less than 2.5 microns in diameter.
[2] DNR's PM2.5 Guidance includes the Technical Support Document appended to the Preliminary Determination for these proposed air permits.

ATTACHMENT B

I. The permit record for the proposed air permits must include PM2.5 emission estimates.

The proposed air permits do not estimate or limit PM2.5 emissions in reliance on the Technical Support Document in DNR's PM2.5 Guidance, which provides that mechanical or low temperature industrial sources do not emit PM2.5 in quantities with the potential to cause a violation of ambient air standards.[3] EPA has already made DNR aware of evidence establishing that mechanical sources do emit PM2.5, and that those emissions can be significant in some cases.[4] Further, EPA recently put DNR on notice that a proposed Title V air permit prepared without PM2.5 emission estimates in reliance on DNR's PM2.5 Guidance will violate the Clean Air Act if issued as proposed.[5]

EPA's comments, included as Attachment B, explain that all Part 70 major source permits must include emission estimates from both stack and fugitive sources in order to comply with Title V of the Clean Air Act.[6] EPA cites recent scientific literature to rebut DNR's conclusion that mechanical, low-temperature sources do not emit significant quantities of PM2.5. We respectfully request that DNR review and respond to the literature cited in EPA's comments.

Further, DNR has data that confirms mechanical processes emit PM2.5. Through an Open Records Request to DNR, MEA obtained emission reports from stack tests at individual sources.[7] Emission reports from stack testing of mechanical processes at several industrial sand mines and processing facilities demonstrate that PM2.5 can comprise a significant portion of total particulate matter (PM) or PM10 sampled in stack tests:[8]

- EOG Resources reported that 70% of total PM sampled was made up of PM2.5;
- Chippewa Sand Company reported one stack test in which 100% of PM sampled was made up of PM2.5, and another in which 75% of PM sampled was made up of PM2.5;
- Chieftain Sand & Proppant, LLC reported one stack test in which 36% of PM10 sampled was made up of PM2.5, and another in which 17% of PM10 was comprised of PM2.5.[9]

The evidence simply does not support the conclusion in DNR's PM2.5 Guidance that mechanical sources do not emit significant quantities of PM2.5. Recent published studies and emission reports to DNR confirm that most mechanical sources, in fact, release PM2.5. We

---

[3] Preliminary Determination, FID No. 603108330, Permit Nos. 15-MHR-064, 603108330-P01, at 3.
[4] Attachment A.
[5] Attachment B.
[6] Attachment B at 1-2; 40 C.F.R. §§ 70.3(d), 70.5(c)(3).
[7] MEA's Open Records Request, No. 15ORR1523, requested "All stack test reports and/or results from testing for particulate matter smaller than 2.5 microns (PM2.5)." MEA compiled the data from the records produced in the spreadsheet included as Attachment C.
[8] PM10 is shorthand for particulate matter less than 10 microns in diameter.
[9] Attachment C.

ATTACHMENT B

respectfully request that DNR revise the proposed air permits and preliminary determination to include PM2.5 emission estimates as required by state and federal law.

II. DNR must model the impact according to the proposed air permits because removal of certain permit limits will increase the facility's potential annual PM2.5 emissions.

DNR asserts that the facility requested removal of limits on production rates, vehicle miles travelled, dry sand loading to truck, and blasting explosive usage because of a change in Wisconsin law.[10] These permit changes will increase the total annual emissions for several regulated pollutants including, PM, PM10, PM2.5, and nitrogen oxides.

In the preliminary determination for the proposed air permits, DNR explains that it did not model ambient air quality impacts of the proposed increased activity because the permit modifications will not cause potential hourly emissions to increase.[11] While this may be the case, the permit modifications do result in significant increases in potential *annual* emissions. This is notable because there is an annual ambient air standard for PM2.5.

Comparing DNR's preliminary determination for the current air permit, 14-MHR-069, with the preliminary determination for the proposed air permits, potential stack emissions of PM10 will increase from 62.2 tons per year (tpy) to 89.3 tpy. Stated otherwise, potential annual stack emissions of PM10 will increase by a factor of 1.435. The preliminary determination for the proposed air permits does not estimate PM2.5 emissions, but multiplying the potential PM2.5 stack emissions in permit No. 14-MHR-069—47.5 tpy—by 1.435 provides an estimate of annual PM2.5 stack emissions of 68.2 tpy for the proposed air permits.

DNR's modeling analysis for Permit No. 14-MHR-069 estimated that the facility's potential emissions plus background would consume 64% of the PM2.5 annual standard when that standard was 15mcg/m3. Comparing the results of modeling to the current PM2.5 annual ambient air standard of 12 mcg/m3, the facility as permitted under 14-MHR-069 plus background would consume 80% of the standard.

Given that the limits removed in the proposed air permits resulted in higher annual emission estimates for PM10, it follows that annual PM2.5 emissions from stack sources would also increase. Wisconsin law authorizes DNR to issue an air permit only where it makes a defensible finding that a source will not violate or exacerbate violation of an air quality standard.[12] For the reasons explained above and supported by the attached documents, DNR cannot support its conclusion that mechanical sources like SSS – Arland Plant do not emit PM2.5. Because

---

[10] Preliminary Determination, FID No. 603108330, Permit Nos. 15-MHR-064, 603108330-P01, at 3.

[11] Preliminary Determination, FID No. 603108330, Permit Nos. 15-MHR-064, 603108330-P01, at 29.

[12] Wis. Stat. § 285.63(1)(b).

potential annual PM2.5 emissions will increase under the proposed air permits, DNR must repeat modeling to ensure compliance with the annual PM2.5 ambient air standard.

We respectfully request that DNR estimate PM2.5 emissions and conduct modeling to ensure compliance with the current annual PM2.5 ambient air standard.

Thank you for considering our comments. Please contact me if you have any questions.

Regards,

/s/

Sarah Geers
Staff Attorney
Midwest Environmental Advocates
312 W. Main St., Ste. 302
Madison, WI 53703
sgeers@midwestadvocates.org
608-251-5047 ext. 5

/s/

Sparsh Khandeshi
Attorney
Environmental Integrity Project
1000 Vermont Ave., NW
Washington D.C., 20005
skhandeshi@environmentalintegrity.org
202-263-4446

ATTACHMENT B

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

AUG 2 6 2015

Ms. Kristin Hart
Chief
Permits and Stationary Source Modeling Section
Bureau of Air Management
Wisconsin Department of Natural Resources
PO Box 7921
Madison, Wisconsin 53707-7921

REPLY TO THE ATTENTION OF:

Dear Ms. Hart:

The U.S. Environmental Protection Agency has reviewed the Wisconsin Department of Natural Resources' (WDNR) draft "Guidance for Including $PM_{2.5}$ (Particulate Matter of less than 2.5 Micrometers) in Air Pollution Control Permit Applications". EPA has some concerns with WDNR's guidance, particularly with WDNR's conclusions that "$PM_{2.5}$ emissions will not be estimated in an air permit review for fugitive dust sources, mechanical handling, grain handling, and other low temperature particulate sources."

EPA is also concerned by WDNR's statement that "Permit applicants should assume that mechanical processes such as crushing, grinding, sanding, sizing, evaporation of sprays, suspension of dusts, etc. are not sources of $PM_{2.5}$ emissions and not include $PM_{2.5}$ emission estimates for these types of sources in the application. This includes applications for all permit types including non-Title V and Title V operation permits, registration and general permits, minor source construction permits, and PSD (Prevention of Significant Deterioration) and NAA (Nonattainment Area) major source construction permits."

EPA's May 20, 2014, "Guidance for $PM_{2.5}$ Permit Modeling" provides "that each permitting action will be considered on a case-by-case basis". Therefore, a blanket $PM_{2.5}$ exemption cannot be given to exempt such a broad range of source types from permitting requirements. All sources need to evaluate their emissions of $PM_{2.5}$ for major source applicability. While some sources with mechanical processes or fugitive dust may have low or negligible emissions of $PM_{2.5}$, this should be determined on a case-by-case basis. There have been numerous $PM_{2.5}$ studies by EPA, academic institutions, and industry groups which demonstrate that emissions of $PM_{2.5}$ from mechanical processes are not all zero. Some examples include the April 2003 Emission Factor Documentation for AP-42 Final Report for Emissions from Grain Elevators and Grain Processing Plants[1], the November 2, 2001 Emission Factors for Barges and Marine Vessels Final Test Report[2], and the "TEOM-Based Measurement of Industrial Unpaved Road PM_{10}, $PM_{2.5}$, AND $PM_{10-2.5}$ Emission Factors" by John Hayden, Vice President for Environmental Affairs, National Stone, Sand & Gravel Association, and John Richards,

[1] http://www.epa.gov/ttn/chief/ap42/ch09/bgdocs/b9s0909-1.pdf

[2] http://www.epa.gov/ttn/chief/ap42/ch09/related/rel_c09s0901.pdf

ATTACHMENT B

Attachment A

President, Air Control Techniques[3], which provided continuous, real time measurement of PM_{10} and $PM_{2.5}$ concentrations and found that a percentage of the PM emitted was in fact $PM_{2.5}$. ("TEOM" is tapered electrode oscillating microbalance, and "PM_{10}" is Particulate Matter of less than 10 Micrometers.)

WDNR's guidance refers to a de minimis level for $PM_{2.5}$, "This memo offers guidance to permit applicants on when it is appropriate to assume that a given emissions unit emits $PM_{2.5}$ emissions above *de minimis* levels..." However, it is unclear what de minimis level WDNR is referencing. The Significant Monitoring Concentration for $PM_{2.5}$ was vacated and the Significant Impact Level for $PM_{2.5}$ was repealed as a result of the January 22, 2013 US Court of Appeals for the District of Columbia Circuit's decision. The significant emissions rate, which is used to determine PSD and Nonattainment New Source Review (NSR) applicability, is not intended to be compared to emissions from individual units, but rather is to be compared to the sum of all emission increases from each unit affected by any given project. While the $PM_{2.5}$ emissions from mechanical processes alone may not result in a significant emissions rate, a project involving multiple emission units, for example both a mechanical process and a combustion unit, may together necessitate PSD review. For this reason it is essential that $PM_{2.5}$ emissions be evaluated on a case-by-case instead of assuming that $PM_{2.5}$ emissions are zero for all mechanical processes.

Further, fugitive PM emissions, including $PM_{2.5}$ are required to be included in calculating the potential to emit of certain stationary sources. These sources include any belonging to one of the 28 named PSD source categories explicitly listed in section 169 of the Clean Air Act (Act) as being subject to a 100 tons per year emissions threshold for classification of major sources and, according to 40 C.F.R. 52.21(b)(1)(iii)(aa) "any other source category which, as of August 7, 1980, is being regulated under section 111 or 112 of the Act." This is important because fugitive emissions can determine whether a source is a major source for purposes of NSR.

Additionally, the major NSR regulations are intended to require each unit that emits the pollutant for which the overall project emissions exceed the significance rate to undergo Best Available Control Technologies (BACT) or Lowest Achievable Emissions Rate (LAER) review, regardless of whether the individual unit's emissions are significant on their own. It is not appropriate to broadly state that $PM_{2.5}$ emission limits, including BACT or LAER, will not be established for mechanical processes. ("Since mechanical processes are not considered significant sources of $PM_{2.5}$ emissions, no $PM_{2.5}$ limitations for these types of emission units will be included in permits for major PSD sources or major modifications to PSD sources.") Rather, if PSD is triggered, a BACT or LAER analysis should be conducted on a case-by-case basis for each unit whose emissions contribute to the net emissions increase of the project.

Overall, EPA does not believe that a broad statement that mechanical processes do not emit $PM_{2.5}$ is accurate or appropriate. EPA believes that such an assumption may cause WDNR to issue permits that are inconsistent with its State Implementation Plan and with the federal major NSR program. EPA urges WDNR to revise this guidance so that it does not apply to major NSR or affect how major NSR applicability is determined.

[3] http://www.epa.gov/ttnchie1/conference/ei14/session7/hayden.pdf

ATTACHMENT B

Attachment A

We appreciate the opportunity to review WDNR's guidance documents and we look forward to working with you to address them. If you have any questions, please feel free to contact Susan Kraj, of my staff, at (312) 353-2654.

Sincerely,

Genevieve Damico

Genevieve Damico
Chief
Air Permits Section

Cc: Kevin L. Gunderson, Environmental Specialist
Ho-Chunk Nation Environmental Health Department
PO Box 636
Black River Falls, WI 54615

ATTACHMENT B

Attachment A

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

APR 2 8 2016

REPLY TO THE ATTENTION OF

Ms. Kristin Hart
Chief
Permits and Stationary Source Modeling Section
Bureau of Air Management
Wisconsin Department of Natural Resources
PO Box 7921
Madison, Wisconsin 53707-7921

Dear Ms. Hart:

The U.S. Environmental Protection Agency has the following comments on the Wisconsin Department of Natural Resources' (WDNR) draft Title V renewal for Expera Specialty Solutions – Thilmany Mill, permit number 445031180-P20 (Expera). In order to ensure that the project meets federal Clean Air Act (CAA) requirements, that the permit will provide necessary information so that the basis for the permit decision is transparent and readily accessible to the public, and that the permit record provides adequate support for the decision, EPA recommends that the following points be addressed:

1) **The permitting record is deficient and does not address Part 70 requirements.**

40 CFR 70.5(c)(3) requires the source to provide emission-related information as part of the permit application, including all emissions of pollutants for which the source is major and emissions of all regulated air pollutants. Pursuant to 40 CFR 70.2, "regulated air pollutant" includes "Any pollutant for which a national ambient air quality standard (NAAQS) has been promulgated" and thus includes particulate matter of less than 2.5 micrometers ($PM_{2.5}$). Further, 40 CFR 70.3(d) requires that fugitive emissions from a Part 70 source must "be included in the permit application and Part 70 permit in the same way as stack emissions, regardless of whether the source category in question is included in the list of sources contained in the definition of major source." WDNR's February 2016 report entitled "Air Quality Review of Industrial $PM_{2.5}$ from Stationary Sources in Wisconsin" (henceforth referred to as the TSD), states that mechanical units are not likely to "cause or contribute to a violation of the NAAQS". A determination that an emission unit does not cause or contribute to a violation of the NAAQS does not necessarily equate to no emissions from the unit. As frequently seen in ambient air impact analyses, an emission unit can emit significant quantities of a pollutant and still not cause, by itself, a violation of the NAAQS. WDNR's statement that mechanical units are unlikely to "cause or contribute to a violation of the NAAQS" does not address the explicit Part 70 requirements to quantify emissions rates. WDNR's failure to consider $PM_{2.5}$ emissions from mechanical sources, including fugitive emissions, is not allowable under Title V of

ATTACHMENT B

Attachment B

the CAA and the permit record is currently deficient. Compliance with Title V requires WDNR to quantify the $PM_{2.5}$ emissions from the mechanical sources at the facility.

2) **The failure to calculate $PM_{2.5}$ emissions from mechanical units contradicts WDNR guidance and could adversely impact implementation of major federal permitting programs.**

Wisconsin's February 2016 "Guidance for Including $PM_{2.5}$ in Air Pollution Control Permit Applications"[1] indicates that WDNR will calculate emissions of $PM_{2.5}$ from mechanical sources only in cases where the $PM_{2.5}$ emissions from high temperature units are greater than 80% of the major permitting program threshold. EPA understands that the 80% threshold ensures that there is an adequate buffer between the source's emissions and the major source threshold, so that applicability determinations are performed in a manner consistent with federal requirements. In this instance, the Expera kraft pulp mill emits 702 tons per year of $PM_{2.5}$ excluding several mechanical sources, and thus is clearly over 80% of the major source threshold. In opposition to its own guidance, WDNR has still assumed a $PM_{2.5}$ emissions rate of zero for several of the source's mechanical units. Excluding the $PM_{2.5}$ contributions of sources is contrary to the language of Title V. The definition of "major source" in 40 CFR 70.2 is based on the total potential emissions of the source, regardless if an individual unit emits a pollutant in quantities smaller than one would expect to cause or contribute to a violation of the NAAQS. Rather than looking at an individual unit, the Title V program looks at the aggregate emissions of all units at the source. Since Expera is a kraft pulp mill, Title V explicitly requires that fugitive emissions from all emission units, including mechanical sources, be included in applicability determination. EPA requests that WDNR calculate $PM_{2.5}$ emissions from the mechanical sources, as required by Part 70 and the CAA.

3) **AP-42 is one resource of many available to estimate emissions**

EPA finds WDNR's line of reasoning in addressing $PM_{2.5}$ emissions on a case-by-case basis from processes P45, P49, and P50 to be problematic. WDNR disagrees with the methodologies used in the Cowherd-Donaldson study, from which the AP-42 emission factor was largely based. As a result of WDNR's perceived weaknesses of the study, WDNR does not use the AP-42 emission factor to calculate $PM_{2.5}$ emissions, and instead does not calculate emissions at all, effectively treating the emission factor as zero. While EPA acknowledges WDNR's concerns that AP-42 may be high, assuming zero is not supported or appropriate. As the introduction to AP-42 states, AP-42 is only one tool available to estimate emissions, and in fact should often be used only if no other information is available. If WDNR takes issue with AP-42, WDNR may use other available resources to determine a more reliable emission factor, including site-specific emission factors, other scientific literature, or emission testing from similar sources must be used to determine the $PM_{2.5}$ emissions. Even if the studies used to develop AP-42 are excluded, as discussed below, several scientific studies give EPA reason to believe that

[1]http://dnr.wi.gov/topic/AirPermits/documents/EmissionsApplicantsGuidanceFinal.pdf

mechanical sources such as haul roads do emit some level $PM_{2.5}$. EPA requests that WDNR rely on existing studies, which suggest that mechanical sources do indeed emit $PM_{2.5}$, to determine $PM_{2.5}$ emissions, rather than assuming that there are zero emissions from the units.

4) **The TSD does not sufficiently address $PM_{2.5}$ emissions at an emission unit level and cannot be used as justification for assuming zero emissions of $PM_{2.5}$ from mechanical emission units.**

The TSD does not include $PM_{2.5}$ emissions rates from mechanical sources, but relies on an analysis of *regional ambient air monitors* in conjunction with critiques of studies performed at the source level to justify assuming zero $PM_{2.5}$ emissions. WDNR's analysis fails to account for what is happening at the source. The TSD provides a brief analysis on direct emissions of $PM_{2.5}$ concluding that EPA emission factors may be overstated.[2] WDNR references a study which finds that the AP-42 emission factor for a natural gas boiler may overstate the actual emissions by as much as 9 times, but this study still finds that $PM_{2.5}$ is emitted in measurable quantities[3]. The study WDNR references only addresses $PM_{2.5}$ emissions from boilers, a high temperature source, which does emit measurable amounts of $PM_{2.5}$ according to WDNR's Guidance for Including $PM_{2.5}$ in Air Pollution Control Permit Applications. The TSD does not provide any analysis of $PM_{2.5}$ emissions from mechanical sources.

On page 20 of the TSD, WDNR states that "elemental carbon is correlated to directly emitted $PM_{2.5}$ from fuel combustion". Figure 16 of the TSD provides $PM_{2.5}$ species trends as measured by Wisconsin speciation monitors. In this figure, it appears that the concentration of elemental carbon is approximately the same as the concentration of soil material, which could be associated with $PM_{2.5}$ from mechanical activities like haul roads. If the ambient elemental carbon concentration represents measurable amounts of $PM_{2.5}$ emissions from combustion units, it follows that the ambient soil material concentration could represent measurable $PM_{2.5}$ emissions from mechanical sources. The permitting record should not rely on the TSD to support the conclusion that emissions from mechanical sources are zero as the TSD relies only on the broader scope of ambient air monitors without providing any analysis of the specific unit. Therefore, EPA requests that WDNR provide justification beyond citing to the TSD for each unit assumed to have zero $PM_{2.5}$ emissions. If such justification is not available, EPA expects WNDR to calculate $PM_{2.5}$ emissions using the best available information.

[2] "Air Quality Review of Industrial PM2.5 Emissions from Stationary Sources in Wisconsin, pg 9
[3] NCASI report titled, "Evaluation of the Performance of EPA Methods 201A and 202 on a Natural Gas-Fired Package Boiler"

ATTACHMENT B

Attachment B

5) **Scientific studies suggests that there are $PM_{2.5}$ emissions from mechanical units such as haul roads and landfills.**

EPA has reviewed a number of recent peer reviewed scientific studies regarding direct $PM_{2.5}$ emissions from mechanical sources such as haul roads and landfills. These studies indicate that such source types do emit a positive, non-zero quantity of $PM_{2.5}$, based on a variety of measurement techniques. While EPA understands WDNR considers the federal reference method or equivalent test method to be the preferred measurement technique, such test methodologies are not well suited for fugitive emission sources such as landfills and haul roads. In the absence of studies using such test methods, EPA expects WDNR to consider results from other reasonable testing techniques, which provide a large body of evidence suggesting that there are some emissions of $PM_{2.5}$ from these source categories. EPA has provided a listing of such studies for WDNR's review in Attachment A to this letter.

6) **Additional Comments**

EPA also requests that WDNR consider the additional comments on the draft permit found in Attachment B of to this letter.

We look forward to working with you to address all of our comments. If you have any further questions, please feel free to contact Andrea Morgan, of my staff, at (312) 353-6058.

Sincerely,

Genevieve Damico

Genevieve Damico
Chief
Air Permits Section

Attachment A
Scientific Studies

Ferm, M. and K. Sjoberg (2015). "***Concentrations and emission factors for PM2.5 and PM10 from road traffic in Sweden.***" Atmospheric Environment 119: 211-219. DOI: http://dx.doi.org/10.1016/j.atmosenv.2015.08.037

Kundu, Shuvashish, and Elizabeth. A. Stone. "***Composition and Sources of Fine Particulate Matter across Urban and Rural Sites in the Midwestern United States.***" Environmental science. Processes & impacts 16.6 (2014): 1360–1370. *PMC*. Web. 20 Apr. 2016.

Piras, L., V. Dentoni, G. Massacci and I. S. Lowndes (2014). "***Dust dispersion from haul roads in complex terrain: the case of a mineral reclamation site located in Sardinia (Italy).***" International Journal of Mining Reclamation and Environment 28(5): 323-341. DOI: http://dx.doi.org/10.1080/17480930.2014.884269

Solomon, P. A., P. K. Hopke, J. Froines and R. Scheffe (2008). "***Key Scientific Findings and Policy- and Health-Relevant Insights from the US Environmental Protection Agency's Particulate Matter Supersites Program and Related Studies: An Integration and Synthesis of Results.***" Journal of the Air & Waste Management Association 58(13): S3-S92. DOI: http://dx.doi.org/10.3155/1047-3289.58.13.s-3

Yuen, W., K. Du, S. Koloutsou-Vakakis, M. J. Rood, B. J. Kim, M. R. Kemme, R. A. Hashmonay and C. Meister (2015). "***Fugitive Particulate Matter Emissions to the Atmosphere from Tracked and Wheeled Vehicles in a Desert Region by Hybrid-Optical Remote Sensing.***" Aerosol and Air Quality Research 15(4): 1613-1626. DOI: http://dx.doi.org/10.4209/aaqr.2014.12.0310

ATTACHMENT B

Attachment B

Attachment B
Additional Comments

1) Please note that EPA expects the court to issue a mandate effectuating the vacatur of provisions of the reciprocal internal combustion engine rules including 40 CFR 63.6640(f)(2)(ii)-(iii), 40 CFR 60.4322(f)(2)(ii)-(iii) and 40 CFR 60.4243(d)(2)(ii)-(iii) on May 2, 2016.[4] EPA identified that several of the provisions that will be vacated are incorporated into the draft permit. Specifically, on page 73 of the draft permit conditions I.M.3.a.(5)(f)(2)(ii) and (iii) incorporates conditions of 40 CFR 63.6640(f)(2)(ii)-(iii), on page 77 of the draft permit conditions I.N.3.b.(b)(ii)-(iii) incorporate 40 CFR 60.4243(d)(2)(ii)-(iii), and conditions I.N.4.b.(2)(b)(ii)-(iii) on page 79 incorporate 40 CFR 60.4322(f)(2)(ii)-(iii). As the permit will not be issued until after May 2, 2016, EPA requests that WDNR remove the vacated provisions from the permit.

2) The permit contains over 25 footnotes. In some cases where the footnote is purely informational, the use of a footnote may be appropriate. However, many of the footnotes included in the permit seem to contain language that is intended to be federally enforceable and should be contained in the body of the permit as an applicable requirement. For example, footnote 13 on page 36 states, "This condition applies to Boiler B11 when burning NCG". Similarly, footnotes 10 and 21 seem more appropriate to include in the body of the permit. Please review all the footnotes in the permit and ensure that any footnote that contains requirements that are intended to be enforceable are included in the permit as permit conditions.

3) On November 20, 2015, EPA published revisions to 40 CFR 63 Subpart DDDDD, the maximum achievable control technology (MACT) standard for boilers[5]. These revisions became effective upon the date of publication. It appears that the language in permit section I.AAA may not reflect the revisions made in the November 2015 rulemaking. As appropriate, please revise the draft permit to incorporate the revisions. Information on the recent rulemakings can be found at the following website: https://www3.epa.gov/airtoxics/boiler/boilerpg.html

4) Condition I.A.1.b.(3)(a) on page 12 includes parametric monitoring for the scrubber C02, but there does not appear to be any associated recordkeeping requirements for the scrubber. Please add the requirement to maintain records of the pressure drop across the scrubber.

5) Conditions I.A.1.c.(5)(a) and (b) on page 13 require the facility to monitor and maintain records of the pressure drop across the multi-cyclone, however no appropriate range in which to maintain the pressure drop is specified. Please provide a range or explain why it is not necessary.

---

[4] https://www3.epa.gov/ttn/atw/icengines/docs/RICEVacaturGuidance041516.pdf
[5] 80 FR 72789

6) EPA noted multiple instances in the draft permit where the facility is required to keep a record of an emission factor, but the emission factor itself is not included in the permit. EPA identified this language in the following conditions: I.A.2.c(3) on page 14; I.B'.5.c(3) on page 36, and I.D.3.c.(2)(a) on page 43. In order to provide transparency and make the information accessible to the public, EPA believes that the emission factor should be publically available.[6] In each case where an emission factor is relied upon to demonstrate compliance, please revise the permit to include either the emission factor or include an explicit method for determining the emission factor.

7) EPA identified several instances where the draft permit requires the permittee to "sample fuels using methods approved by the department in writing". Specifically, EPA noted this language in condition I.A.5.(c)(2) on page 15, condition I.A'5.c.(3) on page 21, condition I.B.5.c.(4) on page 30, and condition I.B'.6.c.(3) on page 37. To improve clarity and enforceability of this condition, EPA suggests adding the required frequency of the sampling and specifying the sampling methodology.

8) Condition I.A'.3.c(3)(d) on page 20 requires the facility to calculate the daily total emissions of sulfur dioxide (SO_2) from all fuels burned but does not provide additional information on the calculation methodology. EPA suggests that to improve clarity of the condition, WDNR include additional information on how to calculate daily SO_2 emissions, including if any assumptions are made regarding SO_2 removal efficiency of the dry sorbent injection system or if 100% of the sulfur content of the fuel is assumed to be emitted to the atmosphere.

9) Condition I.A'.5.b.(1) on page 21 states that tire derived fuel (TDF) may not supply more than 10 percent of the heat input to the boiler or the highest heat input that demonstrates compliance with the particulate matter (PM) limitations of conditions A'.1.a.(1) and (2). However, it is unclear what heat input of TDF demonstrates compliance with the PM limits, and how that is determined. EPA suggests clarifying the permit language to include whether an emission factor is used or testing will be performed to determine the maximum allowable heat input from TDF to not cause a violation of the PM limits.

10) Condition I.B'.1.(6) on page 32 of the permit prohibits the facility from injecting sorbent into the boiler flue gas unless the emissions from the boiler are controlled by the baghouse. However, it does not appear that there is associated recordkeeping requirements. EPA suggests that WDNR require the facility to maintain records of all times that the sorbent was injected into boiler flue gas when the baghouse was not operational.

---

[6] *See* In the Matter of United States Steel Corporation – Granite City, Permit No. 96030056 (Order on Petition) at 9-12 (December 3, 2012) http://www.epa.gov/region7/air/title5/petitiondb/petitions/uss_2nd_response2009.pdf

ATTACHMENT B

Attachment B

11) Several conditions require the facility to keep monthly records of the "amount" of fuel fired in each boiler. The boilers referenced each burn a variety of fuel types. EPA identified this language in Condition I.A.1.c(3)(b) on page 12, condition I.A'.1.c.(3) on page 18, condition I.B.1.c.(8)(b) on page 25 and condition I.B'.1.c.(3) on page 32. To improve enforceability and clarity of the condition, EPA suggests specifying what metric should be used to quantify the amount of fuel burned, for example tons, gallons, or cubic feet, similar to the language in condition I.A'.3.c.(3)(a) on page 20.

12) Condition I.K.3.b.(2) on page 67 of the draft permit requires the facility to calculate on a monthly basis, the volatile organic compounds (VOC) emissions from the paper machines 11, 12, 13, 14 and 15 collectively. However, the emission limitation of I.K.3.a.(3) limits the VOC emissions from P11, P13, and P15 in pounds per month individually. EPA requests that WDNR revise the monitoring and record keeping requirements to ensure that records and emissions are calculated for individual paper machines. Additionally, EPA suggests clarifying the emission calculation methodology to ensure that the permit is both clear and practically enforceable.

13) Condition I.K.3.c.(2) requires that the permittee keep "documents" that show the VOC content of each raw material used by each paper machine. To improve clarity of the condition, EPA suggests that WDNR specify what type of documentation is acceptable- for example, material safety data sheets or manufacturer specifications.

14) Permit Condition I.M.1.b.(1) requires that generator G3 only burn diesel fuel oil and that generators G11 and G14 only burn natural gas, and the only associated recordkeeping is that the permittee keep records of the fuels the generator is designed to use. However, it is unclear from the permit record if the generators are capable of burning an additional fuel type. If so, it may be appropriate to require the facility to maintain records of the fuel burned in the generators. If appropriate, please consider revising the permit condition or confirm that generator G3 is only capable of burning diesel fuel and generators G11 and G14 are only capable of burning natural gas.

15) When an applicable requirement provides independent compliance options or includes decision trees that must be followed to determine an applicable requirement, EPA believes that to ensure clarity, only the options selected by the source and final results of following the decision tree for the specific source should be included in the Part 70 permit.[7] It appears that that the boiler MACT provisions incorporated in permit section I.AAA include all the provisions of the MACT, including conditions that do not apply to boilers B07, B09, and B11. For example, on page 103 of the draft permit it appears that

[7] See page 39 of White Paper Number 2, https://www3.epa.gov/ttn/caaa/t5/memoranda/wtppr-2.pdf

Condition I.(3) could be removed as none of the boilers are considered to be new or reconstructed units. To improve clarity and practical enforceability of the permit, EPA requests that WDNR revise the permit to incorporate only the applicable boiler MACT requirements and identify the compliance options selected by the facility.

16) Condition I.ZZZ.2(a)(1) requires the facility to conduct emissions testing for boiler B07-B11 and Lime Kiln 12. All of the boilers have the capability and are permitted to burn multiple types of fuel, but it is unclear from the testing requirements which fuels the boilers are required to burn during emission tests. Please consider revising the emission testing requirements to specify which fuel should be burned during testing.

17) While EPA understands that Condition I.R.3.a.(b)(1) on page 86 is a state only requirement, for clarity and practical enforceability of these conditions EPA suggests that WDNR consider adding the date by which this plan must be developed, whether updates are required, and if the plan should be submitted to WDNR.

18) Additionally EPA has identified the following typographical errors:

   a. On page 21 it appears that the limitation section of I.A'.5 was erroneously labeled 'b.' instead of 'a.'.
   b. On page 108 of the draft permit it appears that condition I.AAA.10.(b).(4)(iii) may have inadvertently been included in the paragraph for I.AAA.10.(b).(4)(ii)(F), causing the rest of the conditions to be misnumbered. If appropriate please consider revising.
   c. It appears that condition I.AAA.13.(d) on page 117 of the draft permit may have inadvertently only cited to the work practice standards according to item 5 of Table 3 of 40 CFR 63 Subpart DDDDD, whereas the language of 40 CFR 63.7540(d) cites to item 5 and 6. EPA also suggests that it may be appropriate to change the phrase "of this subpart" to "of 40 CFR 63 Subpart DDDDD" to improve clarity.
   d. It appears that 40 CFR 63.7550(c)(5)(xviii) may have inadvertently been left out of the permit requirements on page 121 of the draft permit. If appropriate please add the missing provision.
   e. It appears that condition I.AAA.17.(d)(3) on page 123 of the draft permit may not be consistent with 40 CFR 63.7555(d)(3). Please consider revising if appropriate.
   f. It appears that the origin and authority to condition I.ZZZ.8.b(6) should read 40 CFR 63.867(b)(4) rather than 40 CFR 63.867(b)(3). If appropriate please consider revising.

ATTACHMENT B

Attachment B

Emission Report Number	Permitee name	Location	Describe industry	Date of Report	Test dates	Unit tested	Total Particulate (PM)			Total PM10			Total PM2.5		
								lb/hr	lb/MMBtu		lb/hr	lb/MMBtu		lb/hr	lb/MMBtu
1	Wisconsin Public Service Corporation - Weston Plant	Rothschild, WI	Coal-fired power plant	9/15/11	7/18/11 through 7/20/11	Unit 3 stack	Total filterable and condensable	72.97	0.0241	Total PM10 particulate (< PM10 + condensable)	59.058	0.0204	Baseline tests (< PM2.5 and Condensable)	39.233	0.0014
							Filterable	25.26	0.0077				Refined Coal tests PM2.5 / PM10	54.397	0.0188
							Condensable	47.725	0.0165						
173	Mullins Cheese Inc.	Knowlton, WI	Cheese processing plant		12/17/13	Permeate Dryer - P02		0.09						0.05	
					12/28/13	Protein Backup Gen - P03		0.485	0.047						
					12/4/13	Permeate Backup Gen		0.593	0.059						
					12/3/13	Cheese Plant Backup Gen		0.32	0.026						
273	UW Lacrosse Heating Plant	La Crosse, WI	Heating Plant	Apr-13	2/12/13, 4/13/13 and 4/18/13	Unit 1 Coal Fired Exhaust Duct							Baseline and CPM	1.2352	0.0352
338	Green Bay Packaging Inc.	Green Bay, WI	Paperboard manufacturing plant	11/20/12	11/1/12	Coater Dryer 1	Total	0.212						0.16	
					11/1/12	Coater Dryer 2		0.119						0.078	
379	Green Bay Packaging Inc.	Green Bay, WI	Paperboard manufacturing plant	10/2/12	9/12/12	Coater Dryer 1		0.237						0.142	
					9/12/12	Coater Dryer 2		0.187						0.104	
419	Manitowoc Public Utilities	Manitowoc, WI	Coal, coke, biomass power plant	10/18/12	8/8/12	Boiler B-28			0.01394					0.0128	
613	Waukesha Iron & Metal, Inc.	Waukesha, WI	Metal shredding plant	1/25/12	1/4/12 through 1/6/12	Metal Shredder Exhaust Stack				Filterable PM	0.033		Total Filterable PM	0.045	
725	Wisconsin Power and Light Company-Columbia	Pardeeville, WI	Coal-fired power plant	10/12/11	9/15/11	Unit 1 stack	Total	543.998	0.0924	Total filterable and condensable	447.516	0.0761	Total filterable and condensable	390.973	0.0663
							Condensable	209.869	0.0354	Filterable	237.648	0.0407	Filterable	181.04	0.0308
806	Chippewa Sand Company, LLC	New Auburn, WI	Frac Sand Plant	7/12/13	5/29/13 and 5/30/13	Dryer Stack	Total	0.18					Total	0.18	
						Building Exhaust Stack	Total	0.17					Total	0.128	
912	The Dairyland Cooperative-J.P. Madgett Station	Alma, WI	Coal-fired power plant	5/3/12	3/22/12 and 3/28/12	Boiler No.1 B25	Total filterable and wet catch	153.42	0.0337	Total filterable and wet catch	146.79	0.0323	Total filterable and wet catch	144.26	0.0317
							Filterable	15.31	0.0034	Filterable	8.67	0.0019	Filterable	6.14	0.0014
982	The Dairyland Cooperative-J.P. Madgett Station	Alma, WI	Coal-fired power plant	3/15/12	2/29/12	Boiler No.1 B25	Total filterable and wet catch	15.37	0.0041	Total filterable and wet catch	12.9	0.0034	Total filterable and wet catch	10.35	0.0028
							Filterable	9.15	0.0024	Filterable	6.68	0.0018	Filterable	4.128	0.0011
1058	Chieftain Sand & Proppant, LLC	New Auburn, WI	Frac Sand Plant	10/3/14	8/12/14	No.2 Rotary Sand Dryer	Total	5.45					Total	0.72	
1120	We Energies Rothschild Biomass Cogeneration Plant	Rothschild, WI	Biomass-based electricity/steam plant	3/12/14	2/4/14 through 2/6/14	Biomass Main Boiler Stack	Total	3.061	0.0037	Total		0.0043	Total		0.004
							Filterable		0.0006						
1473	Georgia-Pacific Consumer Products LP	Green Bay, WI	Recycle pulp and paper mill	7/17/14	8/12/13 through 8/15/13	Paper Machines 5 and 6	Total	2.69		Total	1.64		Total	1.51	
1718	Georgia-Pacific Consumer Products LP	Green Bay, WI	Recycle pulp and paper mill	7/17/14	9/9/13, 4/17/14, and 4/18/14	Paper Machine 1	Total	5.23		Total	3.04		Total	2.73	
2041	Georgia-Pacific Consumer Products LP	Green Bay, WI	Recycle and pulp paper mill	7/17/14	6/3/13	Paper Machines 7 and 8	Total	4.03		Total	2.17		Total	1.92	
2369	Mullins Cheese Inc.	Knowlton, WI	Cheese processing plant	8/1/14	6/2/14 through 6/4/14	Whey Protein Dryer Exhaust	Total	0.01					Total	0.01	
2414	Great Northern Sand, LLC	New Auburn, WI	Frac Sand Mine/Plant	12/13/12	11/12/12 through 11/15/12	Dryer (P04, S04)-11/14/12		0.25							
						Dryer (P04, S04)-11/15/12	Total						Total	0.56	
						Sand Handling (P05, S05)-11/15/12	Total						Total		
2512	Green Bay Packaging Inc.	Green Bay, WI	Paperboard manufacturing plant	5/1/13	4/17/13	No.7 Coater (SC7)	Total	0.6		Total	0.51		Total	0.43	
2546	Louisiana-Pacific Corporation	Tomahawk, WI	Wood siding plant	7/2/13	5/29/13 and 5/30/13	No.2 Baghouse Stack							Total	0.159	
2643	Madison Metropolitan Sewage District	Madison, WI	Municipal Sewage Treatment/Digester Plant	7/16/14	5/27/14	Biogas-fired boilers exhaust stack				Total	0.031		Total	0.024	
2691	Wisconsin Power and Light Company-	Sheboygan, WI	Coal-fired power plant	7/26/10	6/8/10	Unit 5 Stack	Total	121.582	0.0245	Total	114.628	0.0231	Total	107.79	0.0217
							Condensable	70.06	0.0141	Filterable	6.954	0.0014	Filterable	37.73	0.0076
2795	Georgia-Pacific Consumer Products LP	Green Bay, WI	Recycle pulp and paper mill	7/17/14	Apr. 2014 and May 2014	Paper Machine 10	Total	5.54		Total	2.67		Total	2.4	
							Filterable	4.34		Filterable	1.46		Filterable	1.19	
							Condensable	1.21		Condensable	1.21		Condensable	1.21	
3122	Chieftain Sand & Proppant, LLC	New Auburn, WI	Frac Sand Plant	12/5/14	10/14/14	No.2 Dryer Building (P12, S12)	Total	0.154					Total	0.069	
3162	Chieftain Sand & Proppant, LLC	New Auburn, WI	Frac Sand Plant	12/11/14	10/14/14	No.2 Dryer Operation (P11, S11)	Total	18.49					Total	1.37	
3204	Georgia-Pacific Consumer Products LP	Green Bay, WI	Recycle pulp and paper mill	7/17/14	5/14/14	Paper Machine 9	Total	3.51		Total	2.29		Total	2.18	
							Filterable	2.22		Filterable	1		Filterable	0.88	
							Condensable	1.3		Condensable	1.3		Condensable	1.3	
3438	Wisconsin Power and Light Company-Edgewater	Sheboygan, WI	Coal-fired power plant	6/6/14	5/15/14	Unit 5 Stack	Total	41.999	0.0107	Total	38.139	0.0097	Total	34.788	0.0088
							Filterable	10.846	0.0028	Filterable	6.986	0.0018	Filterable	3.636	0.0009
							Condensable	31.153	0.0079						
3438	Wisconsin Power and Light Company-Edgewater	Sheboygan, WI	Coal-fired power plant	6/6/14	5/16/14	Unit 5 Stack	Total	26.313	0.0066	Total	22.359	0.0057	Total	17.208	0.0044
							Filterable	10.846	0.0028	Filterable	11.416	0.0029	Filterable	6.265	0.0016
							Condensable	31.153	0.0079						
3733	Chieftain Sand & Proppant, LLC	New Auburn, WI	Frac Sand Plant	3/28/14	2/18/14, 2/19/14, 3/10/14	Dryer (P01)	Total	0.94		Total	0.73		Total	0.26	
						Building 1 Baghouse (P02)	Total	1.02		Total	0.42		Total	0.072	
						Rail Loadout (P04)	Total	0.013							
3838	Appleton Coated, LLC	Combined Locks, WI	Coated paper plant	1/25/13	11/28/12 and 11/29/12	Boiler 10 Stack	Filterable	1.397	0.0039	Total	4.034	0.0115	Total	3.878	0.0111
4153	EOG Resources, Inc.	Chippewa Falls, WI	Frac Sand Processing Plant	4/16/12	2/13/12 and 2/14/12	Natural gas-fired dryer 1(P01)	Total	1.3							
						Natural gas-fired dryer 2 (P02)	Total	1.3							
						Product Storage Silos	Total	0.12							
						Dryer Building Dust Collector 1 (P04)	Total	1							
						Dryer Building Dust Collector 2 (P05)	Total	1							
						Rail Loading with one conveyor (P06)		0.23	0.0016				Total	0.16	0.0011

ATTACHMENT B

Attachment C

Comments to Midwest Advocates on Monitoring Protocol for the "Richards Study"

Location of Ambient Air Monitors

The locations of the ambient air monitors or samplers used in the Richards study do not allow for accurate measurement of the facility's impact on ambient air quality, either at the site or in the surrounding community. Historically the DNR had not allowed monitoring data to be accepted for any purpose, unless the sites had been reviewed to be acceptable as being properly sited. This includes their own monitors, industry sites, or in cases such as this, sites that would be used to support major DNR protocol. Traditionally a set of wind rose data would be used to show appropriate monitoring locations downwind of the plant operations. Dispersion modeling data may also be used to supplement the wind rose data which can show the most probable plume locations using both annual and short-term (24-hr) averages. Modeling data can also provide depth to the analysis, accounting for heights of sources and plume rise to show the distance to the greatest ground-level concentration, the best overall location to site the monitor.

In the Richard's study there are wind rose data included to support the monitor siting (referencing "upwind" and "downwind" locations relative to plant operations), but the site locations don't appear to correlate properly with what is indicated by Richard's wind rose information, in fact the monitors in several cases are sited the exact opposite direction from that intended (meaning the sites are located upstream of prevailing winds, where the study references downstream locations and vice versa). Note that wind roses show the largest "tails" where winds are from that direction.

Specific comments are provided here regarding appropriateness of individual sampling sites and designation as "upwind" or "downwind". Richard's Figure 1 locates monitoring location 1 and 2 in Chippewa Falls, WI. At this location the biggest wind rose tail is from the north-northwest, with a lesser wind rose tail from the south west. With these winds you would expect to site monitoring location 1 to the south-southeast or to the northeast of the facility, where the winds would traverse significant plant features, but this is not the case. Location 1 is to the northwest corner of the property, where NO plant features (driers screens, loadout or even roadways) are located. When the wind is out of the most prevalent northwest direction it is not upwind of any plant features.

Location 2 is affected by a similar scenario. It is located at a considerable distance to south-southwest of the plant, where only the northeast winds would traverse the plant. But the wind rose pattern shows this to have the absolute least likely wind occurrence. To capture the most frequent winds it should have been sited to the southeast, or a second choice, to the northeast.

The same is the case for the DS mine (see fig. 3 and 4) for the related sampling location 1 and 2. The wind rose shows a very prominent tail to the south (very prominent winds directly out of the south. The Richards selected location for sampling location 1 and 2 are shown to the south of key features and therefore are not downwind of the plant. I initially thought that there might be a hit from some processing, screening and loadout areas, but on closer analysis the sampling locations are both at least 30-40 degrees east of the prevailing winds, which form a very narrow N-S spike.

Data from maps for the S&S mine, sample location 1, is located such that it may be somewhat more impacted by winds traversing the plant (the main quarry area) - an appropriate location. Location 2 is not located in a manner that it will likely get significant plant impacts.

ATTACHMENT C

For the DD Mine once again neither sampling location 1 or 2 will likely see significant impacts from the processing areas at the mine, although Location 2 may receive minor impacts from a more distant quarry (although map scales are not available to identify distances).

To summarize, there are 8 monitoring locations and only one appears to be properly site to capture the greatest plant dust loading. These locations represent the on-site impacts. Although the monitors may be close enough to capture crystalline silica or PM-2.5 emissions, they are clearly not located to capture the highest plant concentrations. Only one of the eight sampling locations was reviewed, as being acceptable based on a review of wind rose data. It should be noted that all of these sampler locations are on-site locations, but my experience suggests that there are not any prohibitive fences surrounding the area. As such these are all ambient air locations, and the PM-2.5 standards would have applied, at the time of the monitoring study, completed in June 2015. The problem with not depicting appropriate downwind locations is significant because Richards (and later DNR) use this as evidence that there is little or no added PM4 or PM2.5 downstream of plant operations. Related emissions were very likely present, but Richard's study failed to properly capture true downwind locations.

Summary of Actual Monitoring Results - Richards Study

The results of monitoring for a nearly 3-year monitoring study are described here, with reference to our spreadsheet, **Table 1**. The previous comments regarding the monitoring approach used are also incorporated into the discussion.

1. The results show that an appropriated 99th percentile value at the S&S location "Downwind site" had a total 24-hr concentration of 27.8 ug/m3, which meets the 35 ug/m3 ambient standard. No other location (upwind or downwind siting) had higher concentrations. If all EPA procedures were met then it could be stated that the monitoring study showed that ambient standards were met. Our previous discussion showed that appropriate protocol was not followed. In fact the study opted to use NIOSH methods (including PM4 instead of PM2.5 and altered intended reference method conditions) in place of EPA protocol to demonstrate compliance with EPA standards.
2. There were several concentrations at 3 of the 8 locations/upwind-downwind designations that were well above the 35 ug/m^3 standard, ranging from 62 ug/m^3 to 165 ug/m^3. But individual high values do not make up a basis for compliance/or violation of the 24-hr ambient PM-2.5 standard. It should be noted that if the DNR wants to accept the monitoring results as overall showing that the standard was met (despite issues with protocol) they would have to accept that the same protocol clearly shows that some of the days had very high concentrations relative to the standard. We probably would recommend that there may be high concentrations, but protocol used is not conclusive. It is unclear what would have happened if the monitoring network had run for a full 3-yr period per the method. Most sites ran 2 months short of this goal and most sites operated only 8 months of the year.
3. The upwind-downwind designations are verified by this monitoring study as not being chosen in an appropriate manner. Our previous comments on general protocol addressed this, and we put the terms upwind and downwind in quotes, throughout the analysis. In no case were downwind concentrations more than 5% different from upwind values, and 50% of the time the upwind values were higher. We feel strongly that if an appropriate monitor siting study was completed with wind rose data and with air modeling approaches the downwind concentrations would be substantially higher. This is significant because the Richard's Study wants to make a point of showing the relative

ATTACHMENT C

difference between upwind and downwind locations. But the fact is these are not upwind or downwind, but merely random designations, and in the opinion of this meteorologist are meaningless.

4. One site had a perturbation. The DS Site had upwind and downwind limiting values (99th percentile) on the same day (11/17/12). As such that day should be thrown out (most likely an episodic high wind day. The next lower day should be included (also in the 20 to 24 ug/m3 range). This does not affect overall results, as the S&S site identified the limiting results.
5. Further, the annual values are included with the summarized concentrations for comparison to the 12 ug/m3 standard. In all cases the 24-hr average values are more limiting.
6. Recent DNR interpretations of this study have chosen to accept the results, and further state that the study shows that concentrations are very low if not inconsequential. Our evaluation indicates that the methods used are not appropriate for demonstrating compliance with the US EPA ambient standards and the results should be thrown out. Even if results were treated as acceptable the 99th percentile values are within a range of 63% to 80% of the 35 ug/m3 ambient 24-hr standard. If the values could accepted as golden they are showing very consequential ambient values. Yet DNR has used this as a basis to reject all PM2.5 programs (permits, modeling, monitoring, etc.) accept where federal major source programs prevail.

Unless the study adheres to all EPA protocol (and abandons NIOSH approaches for PM2.5), and unless the study is carefully designed to show worst-case impacts from sources upstream (a true downwind site) for all locations the "study" results cannot be accepted. Perhaps a somewhat smaller study could be completed (2 upwind and 2 downwind locations) at perhaps two general sites, which could be carefully crafted using 100% EPA protocol. Such results could be considered for DNR policy directions. Any policies developed by DNR based on the Richards study should be examined and rejected.

Above Comments are provided by:

James J. Fleischmann,

President, Principal Consultant

Pollution Technology, Inc.

James J. Fleischmann 6/27/2016

ATTACHMENT C

Comments on Health Impact Assessment
Kirstie K. Danielson, Ph.D.
Epidemiologist and Public Health Expert
Kirstie.k.danielson@gmail.com

Health Outcomes

- Use of county-level health statistics (Table 3.5) to compare the health profiles of mining counties vs. the state of WI is misleading.
    - There are many reasons a given county's health statistic (for example, the prevalence of adults with asthma) may differ from another county's and the state's respective health statistic, such as differences in the rate of poverty, minority populations, access to health care, etc. between counties and the state. Any difference cannot be solely linked to sand mining.
    - County-level data such as this is called ecological data and can help generate hypotheses, but individual (citizen) level data on health outcomes are needed to begin to investigate "cause and effect."
    - The use of brown shading in the table to highlight the "greatest discrepancies" between the counties is an amateur approach. I looked at the actual raw data from the reference cited (Behavioral Risk Factor Surveillance System 2011-12), and the estimated confidence intervals around the averages overlap (for example, adults with asthma) indicating there are no statistically significant differences. The brown shading is therefore misleading.
- Appendix A comparing asthma rates by county is similarly misleading.
    - See first 2 bullets above.
    - The authors make an amateur mistake in describing their statistics. They did not (and could not) use a Fisher's exact test for this type of data.

Therefore, in my opinion, the conclusions of the HIA should be that there are NO data available yet on a link between sand mining and human health outcomes. There could be an important association between poor health outcomes and sand mining, we just don't have the data yet to conclude either way. Instead, the HIA concludes that "sand mining in Wisconsin appears unlikely to affect human health." (page 38)

As we have learned from almost a century of research on environmental health and chronic disease, it can take several years to decades for many of the diseases of interest to develop, therefore data from a time frame of a few years cannot be used to draw valid conclusions. We should learn from the previous mistakes of relying on industry-sponsored research on the effects of smoking, second-hand smoke, asbestos, etc. and take an approach that better ensures public health and wellbeing.

Air Quality

- With regard to the two industry-funded studies authored by Richards & Brozell 2015 (page 35):
    - The study published in Atmosphere is a peer-reviewed journal. The impact factor of the journal is ~1, which is low for scientific publications. The other journal Mining Engineering does not appear to be peer-reviewed.
    - Both studies were fully funded by the industry and written by authors from a private company who were "private contractors." Despite this, the authors state they have "no financial interest in the facilities sampled." But perhaps other facilities?

ATTACHMENT D

- The first author, John Richards, was recently given an Award of Excellence by the National Industrial Sand Association.

- For the paper in Atmosphere:
  - The authors do not present the full distribution of the raw data, for example in Table 2. They report the number of days above the LOQ (limit of quantification) but not the number of days above 3.0 ug/m3. They also present the 99th percentile, but not the maximum levels. Therefore, with 2128 twenty-four hour average sample values, 1% of the measurments at a given site would be above the 99th percentile levels at the respective facility. In theory, 21 days would be higher than the 99th percentile level, but we are not told how many of those were above 3.0 ug/m3.
  - Therefore, we don't know if the authors are withholding data on unhealthy exposure levels.
- In contrast, Walters et al., 2015 was publically funded and written by public employees. The Journal of Environmental Health in also a peer-reviewed journal with an impact factor of ~1.

ATTACHMENT D