WISA
WISCONSIN INDUSTRIAL SAND ASSOCIATION

Groundwater and Industrial Sand Mining

What is groundwater?

Groundwater is water that occurs in a saturated underground geological formation of rock or soil [1] called an aquifer. Wisconsin has four principal aquifers: 1) the sand and gravel aquifer; 2) the eastern dolomite aquifer; 3) the sandstone and dolomite aquifer; and 4) the crystalline bedrock aquifer. [2] The Wisconsin Department of Natural Resources (WDNR) estimates that Wisconsin's aquifers hold 1.2 quadrillion gallons of groundwater. [3] The depth at which soil pore spaces or fractures and voids in rock become completely saturated with groundwater is called the *water table.*

What concerns have members of the public raised about the potential impact of industrial sand operations on groundwater?

There are two basic activities involved in industrial sand production: 1) mining the sand; and 2) processing (washing and drying) the sand. Some facilities conduct both mining and processing at the same location; in other cases, mining takes place at one location, and processing at another location.

Members of the public have expressed two common concerns about the potential for industrial sand operations to negatively impact groundwater: 1) that pumping groundwater for use to process (wash) sand will diminish the *quantity* of groundwater available to municipal water wells, private water supply wells and surface water such as streams and lakes important to local ecosystems; and 2) that sand mining will impact the *quality* of groundwater through the introduction of contaminants.

Does Wisconsin regulate the potential impact of industrial sand mining operations on groundwater?

Yes. Industrial sand mining in Wisconsin is regulated under a combination of statutes and rules that apply to all industrial, commercial, and agricultural activities.

How do WDNR regulations protect groundwater <u>quantity</u> near industrial sand operations?

WDNR regulations protect groundwater quantity by requiring WDNR approval of the installation of any high capacity well system [4] [5]. As explained on its website, WDNR "reviews each application for a new high capacity well to determine whether the well, along with other wells on the same property, would result in significant adverse environmental impacts to waters of the state – which includes all streams, lakes, wetlands and public and private wells. Following completion of a technical review, if the DNR determines the well could directly result in significant impacts, the DNR would either deny the well application or impose conditions on the construction and operation of the well to prevent such impacts. The DNR bases the need to impose conditions or deny an application on the projected impacts to the affected water resource, e.g., estimated reductions in stream flow or lake level, and the resultant impacts to water temperature, the fishery and other ecological aspects of the stream or lake. In conducting these assessments, DNR considers site-specific hydrogeology, separation distance between the well(s) and the water resource, the hydrology and characteristics of potentially-affected surface waters, construction details of nearby wells, characteristics of the proposed wells such as construction, pump capacity, and the water use and pumping schedule for the proposed well and any other existing wells on the property."[6]

How is water used in a typical industrial sand operation? How much is used?

Industrial sand operations use water to wash sand, suppress dust, irrigate landscaped areas, transport sand as a slurry, and provide water for common potable and non-potable purposes. Rather than use water once, treat it, and discharge it to a receiving stream, most industrial sand operations use water in an essentially "closed-loop" system that continually recycles and reuses water to minimize the volume of fresh makeup water needed. Because these closed loop systems are not perfectly closed and some water is lost, some fresh makeup water is required.

Some industrial sand operations obtain water directly from the ground if mining below the water table and supplement that with water from one or more high capacity wells. Due to the porous nature of sand, operations that mine sand below the water table remove groundwater from the aquifer during mining. Other sand mines do not encounter groundwater during the mining process; these operations remove the sand from above the water table and thus have minimal potential for impact on groundwater as a result of the removal of sand from the ground.

If water obtained directly from the sand mine is insufficient for operational needs, industrial sand mines may also obtain water by pumping groundwater from a high capacity well system, subject to the WDNR regulatory requirements described above.

Depending on the capacity of the sand washing operation, a typical closed-loop industrial sand processing operation contains from less than 1 up to 3 million gallons of water within the system. During sand washing and drying, water is removed from the system through retention in the fines that are washed out of the sand and through evaporation from the sand during the drying process. Depending on the capacity of the washing and drying operation, a source of make-up water on the order of 500 to 2,000 gallons per minute (gpm) is required to replenish losses to the closed-loop system.

What is dewatering?

Mining operations that remove sand from below the water table surface also remove the groundwater adhering to the sand grains. Groundwater will continue to flow into mines where mine floor and walls are open below the water table surface. To keep a mine dry, the groundwater that enters the mine is pumped out of the mine; this process is referred to as dewatering.

Some operations conduct what is called dredge mining. In that case, the water is maintained at a level to form a pond; the dredge floats on the pond, and the sand is mined from below the level of the water.

Where does the groundwater pumped for the industrial sand operation end up?

Except for a relatively small amount of water that evaporates during mining and processing, essentially all of the groundwater that is pumped from the aquifer is retained in the geographic basin that comprises the surface water-groundwater aquifer system. Water that may be discharged from a mine during dewatering remains within the geographic basin with discharge occurring under a permit issued by the WDNR. As a result, there is no material net loss of water from the surface water-groundwater system.

How do WDNR regulations protect groundwater <u>quality</u>?

WDNR regulations protect groundwater quality by setting restrictions and limits that are protective of human health and the environment. These limits are formulated through health-based studies and codified as

groundwater quality standards called Preventive Action Limits (PALs) and Enforcement Standards (ESs) under Wis. Stat. ch. 281 and Wis. Admin. Code ch. NR 140. WDNR issues Wisconsin Pollutant Discharge Elimination System (WPDES) permits to regulate discharge of process water and establishes applicable groundwater quality standards in the WPDES permit.

WDNR regulations also protect groundwater quality through other regulatory requirements to which industrial sand operations must adhere, such as:

- The Wisconsin Spill Law, s. 292.11, requires immediate reporting to WDNR and cleanup of any hazardous substance spills. See WDNR publication Hazardous Substance Spills Reporting Requirements at http://dnr.wi.gov/files/pdf/pubs/rr/rr558.pdf
- Water-supply well construction requirements that set location, design and construction standards for wells to prevent pollutants on the land surface from entering the aquifer (Wis. Stat. s. 281.17 and Wis. Admin. Code ch. NR 812);
- Monitoring well and borehole abandonment requirements to prevent pollutants on the land surface from entering the aquifer (Wis. Stat. s. 160, 227 and 281 and Wis. Admin. Code ch. NR 141)
- Spill Pollution Control and Countermeasures (SPCC) plans are developed and implemented. The SPCC plan identifies potential sources of surface pollution and potential spills of oil-related materials and other chemicals and establishes controls to minimize any impacts to surface water or groundwater related to accidental releases.

What about the use of polymers in industrial sand operations?

Water soluble polymers are used in the industry because the sand is washed with water. The washing process makes the industrial sand clean and ready for use. The source of most industrial sand mined in Wisconsin is sandstone, which is 95% to 99% sand and 1% to 5% very fine particles (silt and clay). Users of industrial sand require a clean grain of sand, without any fines or impurities. After mining, sand is rinsed or "washed" using water to remove the silt and clay particles.

When the sand is washed, the fine particles become suspended in the wash water. Polymers are used to clarify or clean the particles out of the wash water. By accelerating the settling of fine particles, the polymers shorten the period of time required to clarify the water for reuse in industrial sand processing. Polymer use greatly reduces the need for new makeup water for sand washing that would come from a well or other source. Using polymers also reduces or eliminates the amount of land area that might otherwise be needed for settling ponds, which are an alternative means of clarifying the wash water.

WDNR regulations protect surface water and groundwater by regulating stormwater and surface water discharges, well drilling, and the application of materials to the land surface with the potential to impact groundwater. Any stormwater or surface water discharge of industrial sand wash water is regulated by WDNR under Ch. NR 216. WDNR approves the application of products containing polymers for sediment control purposes under DNR Conservation Practice Standard 1051 to protect surface waters. WDNR has not established specific groundwater standards for polymers under Ch. NR 140; however, if the wash water is held in a pond, WDNR reports that "[s]ealed ponds will have very little potential for groundwater impacts. Unsealed ponds will likely seal themselves with the fines that are removed from the frac sand."[7]

For more information, see *Water Soluble Polymers and Industrial Sand Mining* [http://www.wisconsinsand.org/assets/Water-Soluble-Polymers-and-Industrial-Sand-Mining-final-5_31_13-.pdf] posted on the WISA website. As discussed in that paper, the use of polymers at industrial sand operations does not pose a risk to public health.

What about chemicals used for blasting sand?

Many sand mines will use blasting techniques as part of the mining process to loosen the sand from the sandstone formation. The most common blasting agent used in mining is a product comprised of approximately 94% ammonium nitrate and 6% fuel oil, generically referred to as ANFO. The typical byproducts of ANFO ignition are carbon dioxide, nitrogen (which comprises 78% of the earth's atmosphere) and water vapor; however, other gases that may be formed include carbon monoxide, nitrogen monoxide and nitrogen dioxide.

There are two ways in which the quality of groundwater could be impacted by blasting sand: 1) release of nitrogen to the groundwater in the form of nitrate, and 2) agitation of the subsurface which causes an increase in turbidity or suspended solids in groundwater.

The release of nitrogen from blasting agents could occur due to 1) incomplete combustion within the blasting borehole; 2) poor storage, transfer and handling procedures; or 3) residual substances associated with blasting adhering to the rock fragments and sand grains. In each of these instances, the blasting agents would be contained on the mined sand and subsequently entrained in the clay, silt and fine sand removed during the washing process. The polymers used in the sand washing process would cause any residuals of the blasting agents to molecularly bond to the fine particles, preventing the residuals from entering the groundwater.

In rare cases, blasting vibrations may loosen silt, sand and rock particles from the sides of an uncased well bore, causing an increase in the turbidity in water derived from a well. When it occurs, turbidity of well water caused by blasting is commonly a short-term problem, but if persistent may require installation of a filter system or modification of the well.

References

[1] Wis. Admin. Code sec. NR 140.05(9)

[2] Wisconsin Natural Resources Magazine – April 2006 accessed at: http://dnr.wi.gov/wnrmag/html/supps/2006/apr06/aquifer.htm

[3] WDNR Water Atlas Data available at http://dnr.wi.gov/topic/SurfaceWater/atlas.html

[4] Under Wis. Admin. Code sec. NR 812.07(53) a "High capacity well system" means one or more wells, drillholes or mine shafts used or to be used to withdraw water for any purpose on one property, if the total pumping or flowing capacity of all wells, drillholes or mine shafts on one property is 70 or more gallons per minute based on the pump curve at the lowest system pressure setting, or based on the flow rate.

[5] Wis. Stats. s. 281.34; Wis. Admin. Code ch. NR 820

[6] WDNR website High Capacity Well Information available at http://dnr.wi.gov/topic/wells/highcapacity.html (last revised July 23, 2013)

[7] WDNR Silica Sand Mining in Wisconsin, January 2012, p. 28 accessed at: http://dnr.wi.gov/topic/Mines/documents/SilicaSandMiningFinal.pdf

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