By Stewart Kasper, KRWA Technical Assistant

Manganese – Not Just a Groundwater Problem

Manganese is a chemical element, Mn, found naturally in the environment. Often, it's found in minerals combined with iron. Manganese is currently listed as a Secondary Contaminant by the EPA and has no Maximum Contaminant Level (MCL). Secondary Contaminants are generally aesthetic concerns with the color and/or taste of the drinking water. Manganese is found in many foods, including whole grains, coffee, and even black pepper.

Traditionally speaking, manganese has been a problem reserved for groundwater systems. However, over the last decade, that has started to change. In recent months, I have received multiple calls from systems dealing with higher-than-normal levels of manganese at their surface water plants.

Manganese levels in surface waters can elevate due to thermal stratification. Water is most dense when it reaches a temperature of 39.2° Fahrenheit. When the water on the surface becomes denser than that on the bottom, it pushes the lower levels towards the top, making room for denser water. When this turnover takes place, it stirs up the lowest water level in the body. This turnover will bring up the decayed organic matter which holds the manganese and releases it into the other layers of the water body. Manganese levels can also increase during significant rain events when water moves much faster through a reservoir or stream. The turbulence on the bottom of the water body stirs up all the organic matter settled there.

Once that happens, it becomes the operator's responsibility to remove as much of the Mn as possible before it finds its way into the clearwell. Many of the complaints I have taken from operators is that things are running great through the plant, but the clearwell has high turbidity. The manganese is staying in soluble form until it reaches the clearwell, where it comes in contact with chlorine. Once that contact is made, the chlorine will oxidize the manganese, creating manganese oxide, an insoluble particle that creates turbidity. If enough manganese passes through the filter, turbidity in the clearwell can exceed the MCL. The manganese oxide not only creates turbidity but will also increase chlorine demand through the clearwell, as well as out in the distribution system. Many water suppliers with manganese problems also struggle to maintain a chlorine residual in the distribution system.

This photo shows samples taken from a raw water source. The blue indicates high iron levels, and the deep orange is showing large amounts of manganese.

Manganese will also cause colored water and the associated complaints at customers' taps. Manganese oxide creates a dark compound that will adhere to the walls of piping. During turbulent events, such as a line break or heavy flushing, it will dislodge from the wall and is usually observed in drinking water as a discoloration in the sink or toilet bowl.

The most popular means of removing manganese in drinking water is the use of sodium or potassium permanganate. This is especially true if the plant was not initially designed for manganese removal. Permanganate is a strong oxidizer and works by converting the soluble manganese into insoluble manganese oxide.

In its solid form, manganese oxide can then be removed by the water treatment plant's filters before it can move on into the clearwell. Permanganate does not only affect manganese, it will oxidize any organic compound found in the raw water. Because of its effectiveness as an oxidizer, careful monitoring practices must be in place. Regular testing of the raw and post-filter manganese levels is critical to ensure that enough permanganate is being fed to avoid problems in the clearwell. With permanganate, there can be "Too much of a good thing".

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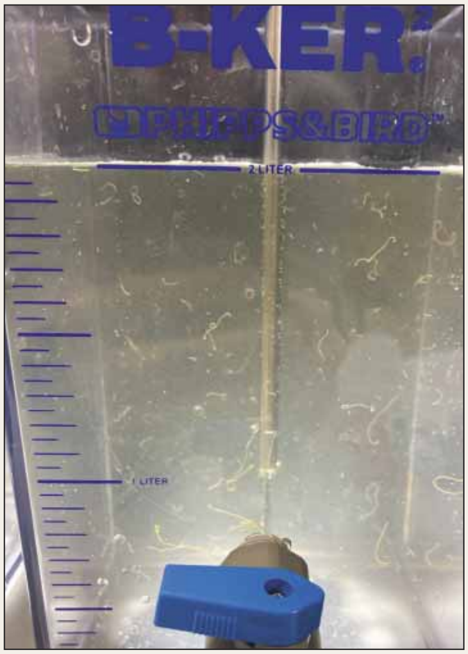
Overdosing will allow the permanganate to reach the clearwell, readily noticed by a pink tint to the water. The idea here is to remove a secondary contaminant, manganese, that makes the water look, smell or taste different. Overdosing the permanganate defeats this purpose. The standard industry practice is to dose the permanganate until there is a clear pink tint in the clarifiers to ensure enough to oxidize the manganese completely. The filters will remove the resulting manganese oxide, and, ideally, very little manganese will reach the clearwell. This takes careful, constant observation. We all know water quality can change quickly, and if the organic load in the raw water decreases, the demand for permanganate will too, allowing the permanganate to stay in solution into filters. In extreme situations, it may make it through the filters as well. It also requires a new way of thinking. As operators, our job is to make safe, clean drinking water, and this notion goes against that very instinct.



Insoluble organics are shown as produced during a jar test dosed with 5 mg/L of Sodium Permanganate.

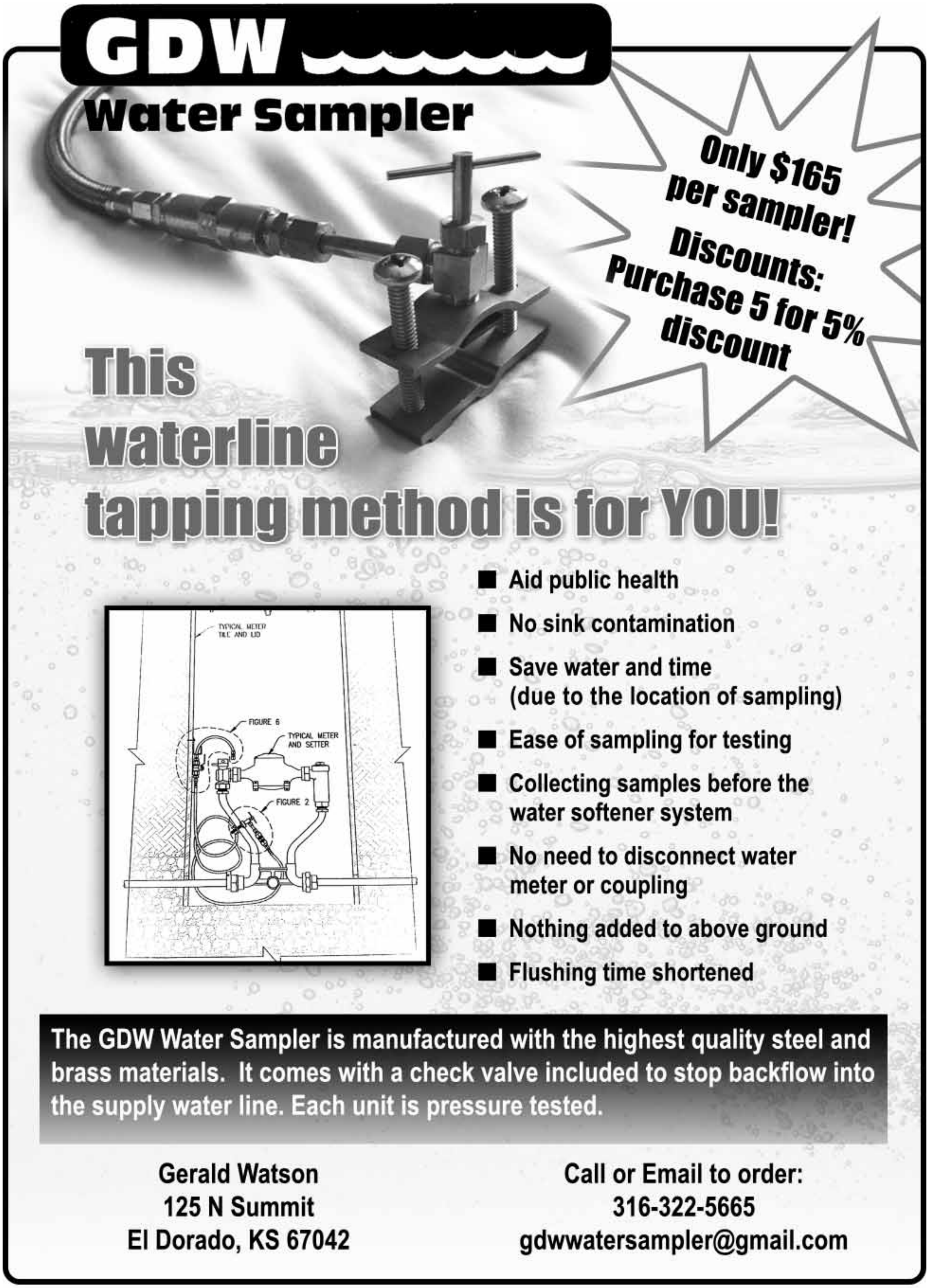
The one big drawback to using a permanganate is that it needs adequate detention time, as much as thirty minutes is ideal for proper oxidation. If the water treatment plant does not have enough detention time between the raw water source and the clarifier, then

Pink water on top of a filter, but was not dosed so high as to make it through the filter, which created ideal manganese results in the clearwell.

perhaps a polyphosphate is the right way to go. Three different types of phosphates can be used to treat manganese: pyrophosphate, tripolyphosphate, and metaphosphate. Determining which polyphosphate a particular plant needs is determined by a jar test. Feeding polyphosphates works in the opposite manner of permanganates. Where permanganates oxidize the manganese into its insoluble form, polyphosphates keep the manganese in solution. Keeping the manganese in solution and bound together with a polyphosphate prevents the manganese from becoming insoluble during disinfection. It will not oxidize out and create turbidity in the clearwell. It also will not increase the chlorine demand in the distribution system. Polyphosphates are typically only useful where the manganese concentration is less than 0.3 mg/L. Polyphosphates do not remove manganese from the water, it only keeps it from affecting the characteristics of the water for a few days. In an oversized distribution system, where the water can often be stored for three or more days, there may be some signs of the manganese being oxidized out in the distribution system. Performing routine manganese tests along with chlorine residual checks throughout the system can give the operator ample information about how the polyphosphate is doing in keeping the manganese in solution.

These are not the only practices in the treatment of manganese, however, these are the most common. Other means such as ion exchange do a great job of removing manganese, but they often come with large capital investments. With the practices mentioned in this article, a simple injection point can be submitted to KDHE for approval and little more is needed than the chemical and a pump. Before using any practices mentioned here, it is recommended to consult with KDHE for best practices and your chemical supplier. I would also be happy to assist with any manganese issues.

Stewart Kasper joined KRWA staff in August 2020 as Technical Assistant/ Trainer. He holds a Class IV operator certification for water and Class IV operator certification for wastewater in Kansas. Prior to joining KRWA, he was water plant operator at Rural Water District No. 2, Miami County.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