Sports Complex TTHM and Corrosion Mitigation Pilot Project

Overview:

The City of Peoria is a Municipal Utility formally incorporated in 1954, serving 191,000 residents-2020 Census. Peoria's water sources are a blend of SRP, CAP, Recovered Well Water, and Groundwater. The high percentage of surface water being treated, coupled with hot summer temperatures, has created challenges for Peoria when it comes to keeping TTHM levels below 80 PPB for Q2 and Q3 compliance samples.

To reduce TTHM levels within the distribution network, D&H Water Systems Inc. proposed a Pilot project at the Sports Complex R103 Reservoirs. D&H Water Systems Inc. provided a TWM-15 Tidal Wave Tank Mixer with a Blower and headspace ventilation system manufactured by Big Wave Water Technologies to be used for the proof-of-concept pilot. The Sports Complex Site has two 1 million gallon tanks that float together, which made this location ideal to do a side-by-side comparison between the Southwest Tank (Tank 1) and Northeast Tank (Tank 2) at this site. The Mixer, Blower and perimeter vents were installed by Superior Tank Inc. in Tank 2 with the mixer located beneath the access hatch at the side of the tank. Four 24" Mushroom vents were installed in quadrants around the perimeter of the tank with a 36" center vent. The blower is installed on Southwest edge of center dollar plate location beneath the center vent. See Figure 1 for details:

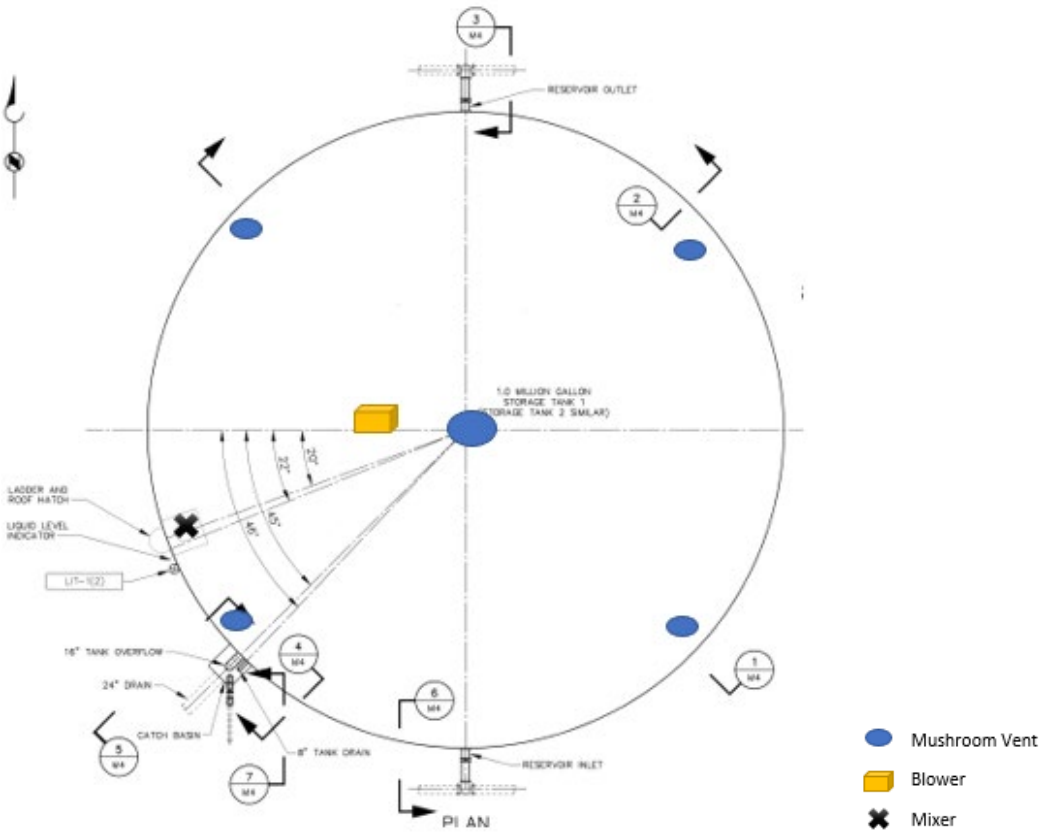

Figure 1

Approach:

Our objective was to reduce TTHM levels without the need for a complete aeration system. To accomplish this, we needed to install a high RPM impeller mixer to increase the air to water interface at the water surface to enable TTHMs to bridge the diffusional barrier. To leverage Henry's Law of Equilibrium, we needed to fully evacuate the tank's headspace. This was accomplished by installing a blower near the center of the tank with mushroom vents installed around the perimeter of the tank to ensure air is being distributed to all parts of the tank with fresh air blowing across the surface of the water. The combination of high energy mixing coupled with active ventilation enables more TTHMs to volatize from liquid to gas and be evacuated from the tank headspace. In reviewing prior years TTHM compliance sampling data, we aimed to provide a reduction of 20-30% in TTHMs at Tank 2. Tank 1 served as our baseline to compare TTHM grab sample results from Tank 2 to validate equipment performance and its ability to remove TTHMs.

In addition to monitoring TTHMs as part of this proof-of-concept pilot, we also monitored Corrosion rate, Temperature, and Relative Humidity within the headspace of both tanks. Corrosion, temperature, and humidity sensors were installed directly below the access hatches in both Tank 1 and Tank 2.

December 16th, 2021 is when the mixer and blower were installed and turned on. Initial grab sample collection was performed by D&H Water Systems Inc. using the THM Plus Waterbath Method 10132 with Hach DR2700 handheld analyzer. Due to sample deviation, it was determined that all TTHM samples shall be processed through a certified lab to ensure sample validity.

Sampling resumed March 22nd, 2022 with TTHM samples being processed through Legend Technical Services, Inc. During this time TTHM levels were very low due to a higher percentage blend of groundwater coupled with cooler outside temperature. At this time, we opted to postpone TTHM sampling until outside temperature increased with a higher percentage blend of surface water making its way through the distribution network.

On July 18th, 2022 a new Blower with HDPE housing was installed to replace the original Blower prototype. Both the mixer and blower were put online July 24th, 2022. Legend Technical Services provided sample analysis for a 4-week span with grab samples being taken at both Tank 1 and Tank 2 starting on 8/11/22, with final round of TTHM samples taken on 9/1/22.

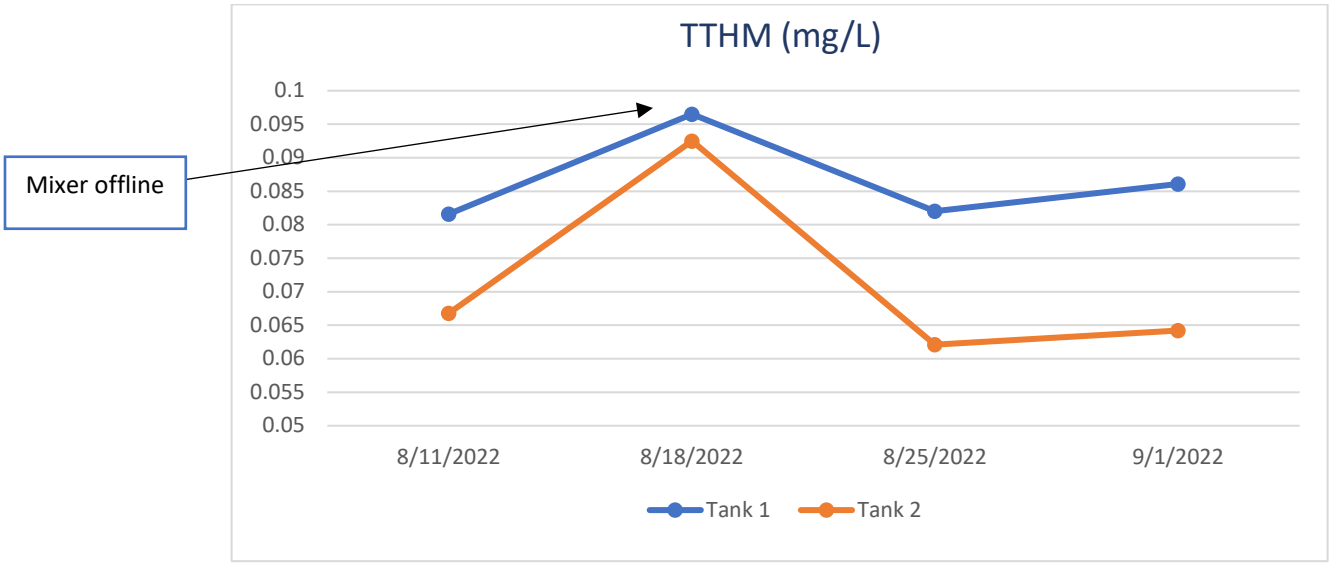

Table 1

Results:

The first samples taken on 8/11/22 show that Tank 1 had a TTHM concentration of 81.6 PPB, while Tank 2 was 66.8 PPB. The mixer was offline for samples taken the following week on 8/18/22 and we can see TTHMs in Tank 1 increase to 96.5 PPB and Tank 2 increased to 92.5 PPB.

The mixer was restarted on 8/19/22 prior to the 8/25/22 TTHM grab sample and we see Tank 1 decrease to 82 PPB, with Tank 2 decreasing to 62.1 PPB. Final grab samples were taken on 9/1/22 showing Tank 1 with a TTHM concentration of 86.1 PPB and Tank 2 at 64.2 PPB.

Due to the nature of how Tank 1 and Tank 2 float together hydraulically, and the fact that we see Tank 1 TTHM levels rising when the mixer in Tank 2 was offline indicates the TTHM Mitigation equipment being used in Tank 2 is also having a positive influence on Tank 1's TTHM levels.

On average, we see Tank 2 with a TTHM concentration that is 23% less than Tank 1 for the 3 weeks of sample collection with both the Mixer and Blower running. Tank 2 experienced a 32.6% reduction in TTHMs within 1 week of the mixer being turned back on between 8/18/22 and 8/25/22 grab samples.

Corrosion Rate Monitoring:

As part of the study to determine the effectiveness of TTHM reduction, CorrTech teamed with Big Wave Water Technologies to study the potential impact the mixer and blower systems would have on the corrosion rate in the tank headspace. Typically, the headspace in drinking water tanks is the most corrosive area due to high chlorine fumes, high humidity, and high temperature. Above water corrosion can be detrimental to the tank structure and can be the root cause of many tank repairs by accelerating the need for complete internal repainting.

CorrTech developed a study plan to install corrosion rate monitoring devices in both tanks and directly measure the corrosion rate during the TTHM reduction process. No specific study of corrosion rates above water in drinking water tanks has ever been done prior to this.

Two corrosion rate devices (CRD) were installed in each tank in the same locations near the roof access hatch. The CRDs were not identical, one CRD was more sensitive to lower corrosion rates and the other was fabricated to measure higher rates and last longer. CRDs were attached to the internal roof surfaces with magnets.

Upon increasing airflow through the headspace, it was assumed that the contributors to corrosion rates would be reduced.

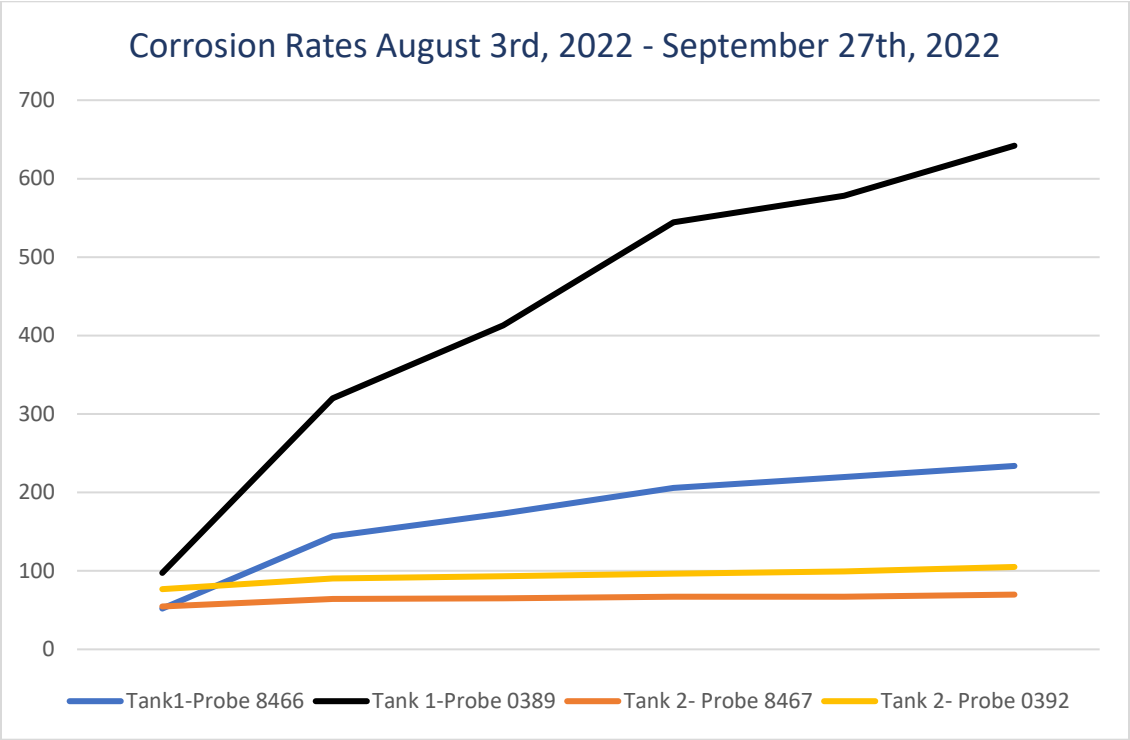

Table 2

The data from the CRDs clearly shows the corrosion rate is 13 to 25 times higher in Tank #1 with no TTHM reduction equipment. The corrosion rate in Tank #1 with the TTHM reduction system is 30 to 233 milliliters per year (mpy) while the rate in Tank #2 is 3 to 9.9 mpy.

This corrosion rate reduction in Tank #2 is impactful to the lifespan of the asset. It is difficult to perfectly paint the complex internal roof structures of these tanks so there is always some exposed steel. Metal loss on the above water surfaces can shorten the life of the coating and the tank leading to premature tank repainting.

The data evaluated thus far is encouraging but must be considered preliminary. The corrosion rates are affected by many factors so a longer test period would increase the confidence of the actual corrosion rates in each tank. So far there appears to be a clear benefit to the use of mixers and blowers in reducing corrosion rates.

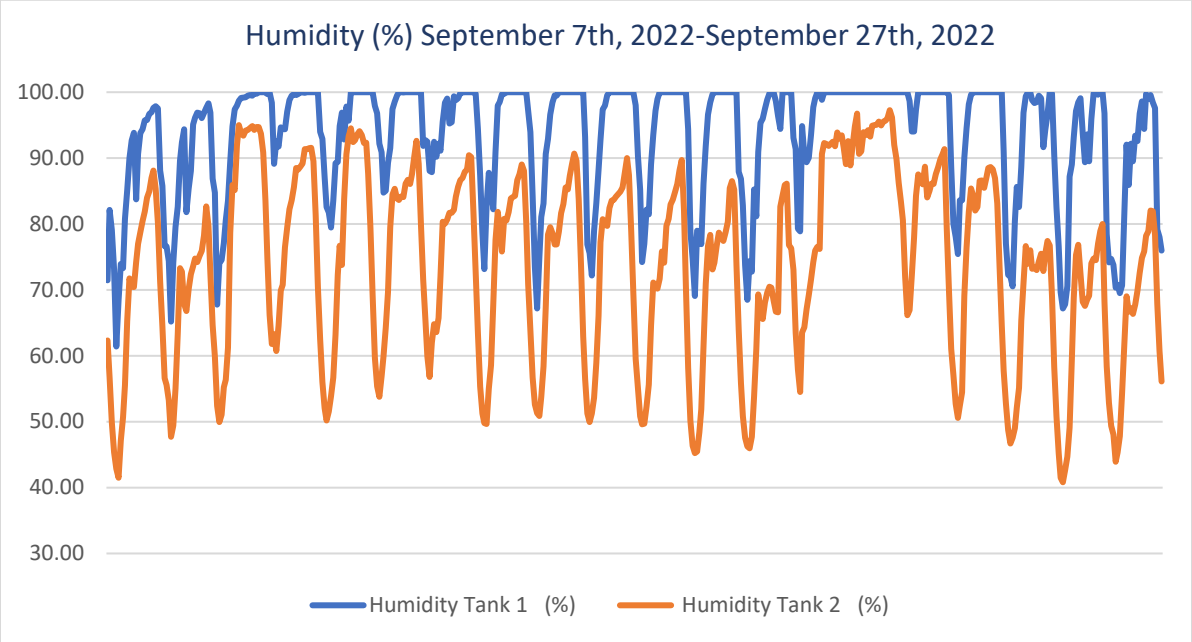

Table 3

Humidity would be reduced by the introduction of drier outside air. This expectation was proven. Table 3 shows the RH% in the tank with no equipment was 20% higher than the treated tank. Drier air reduced condensation and moisture on the steel which acts as the electrolyte in the standard corrosion cell.

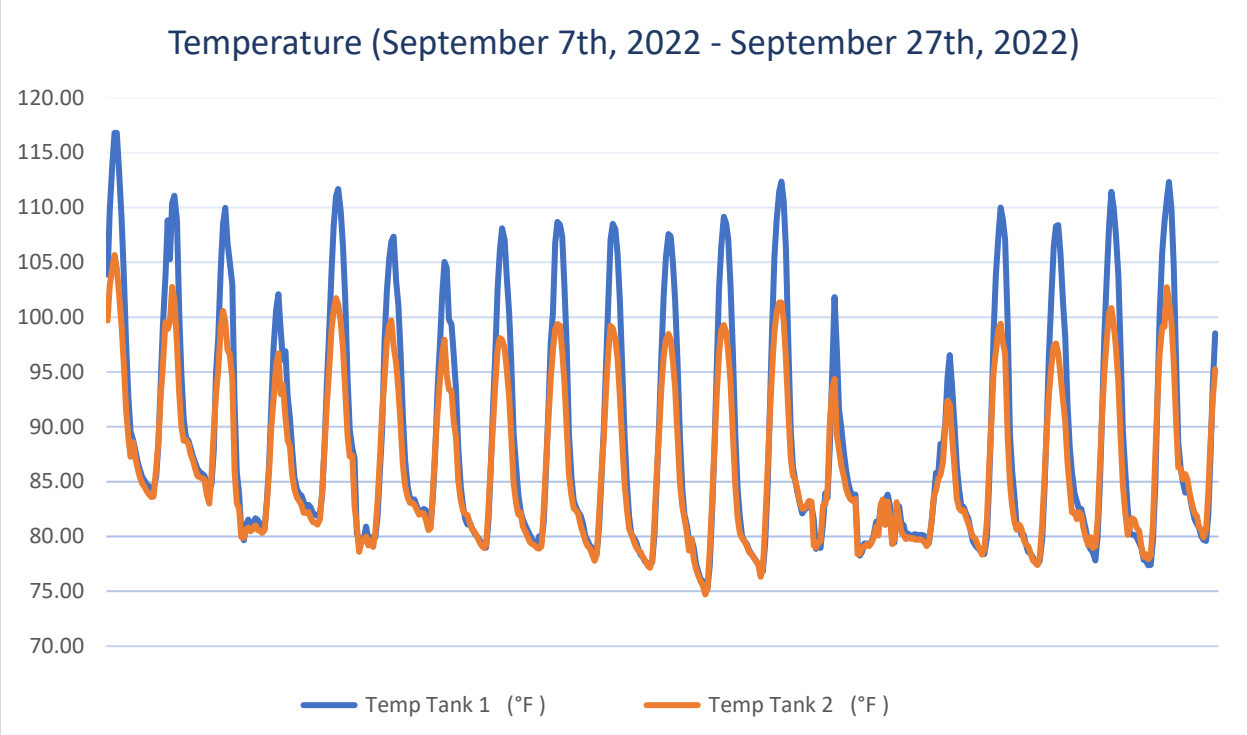

Table 4

Air and surface temperatures will be reduced by pulling in exterior air. The data shows a reduction of 5 to 10 degrees in air temperature; however, the actual temperature of the steel surfaces was not measured. Chemical reactions like oxidation are all accelerated by higher temperatures, but there is not enough data to know how significant the temperature reduction was.

Conclusion:

The City of Peoria has become a valued partner throughout this process. We sincerely appreciate the opportunity to prove this concept in an online tank within the potable distribution system. Conceptually, the goal of enhancing TTHM removal through post-treatment mixing and ventilation was achieved. Additionally, the proof of concept for post-treatment TTHM mitigation also had a dramatic effect on headspace humidity and corrosion rates. The data collected shows that tank mixing coupled with active ventilation provides a cooler, dryer, less corrosive environment for the headspace within the steel tank while simultaneously promoting volatilization of TTHMs to gas, thus reducing TTHM concentrations present within liquid phase of grab samples collected. The equipment solution provided has been able to address a water quality improvement objective of reducing TTHMs, while also providing enhanced asset longevity to the potable water storage tank.