

## ResidualHQ© Deployment & Initial Operation Report

This paper analyzes the field deployment of the first ResidualHQ© Automated Disinfectant Control Workstation (RHQ).



**Project Overview-** The RHQ was deployed to manage chloramine disinfectant residual at a 200,000-gallon elevated water tank serving a 1.3 square mile area. This tank had an average usage of 200,000 gallons per day with a history of low residual and nitrification.

**Results Overview-** Residual levels within the tank have consistently been above compliance levels since the RHQ system was put into service. The possibility of nitrification events have also been significantly reduced.

**Start Up-** The RHQ system was commissioned on October 5<sup>th</sup> 2019 with the initial start-up being managed by Tye Williams and Adam Ness. They performed manual dosing functions until the disinfectant residual was approximately 2.0 mg/l. Automated dosing was then initiated and the RHQ began operation according to set system parameters. The residual target was set for 2.0 mg/l with the action threshold set at 1.8 mg/l.

## ResidualHQ® Operation Analysis Figure 1

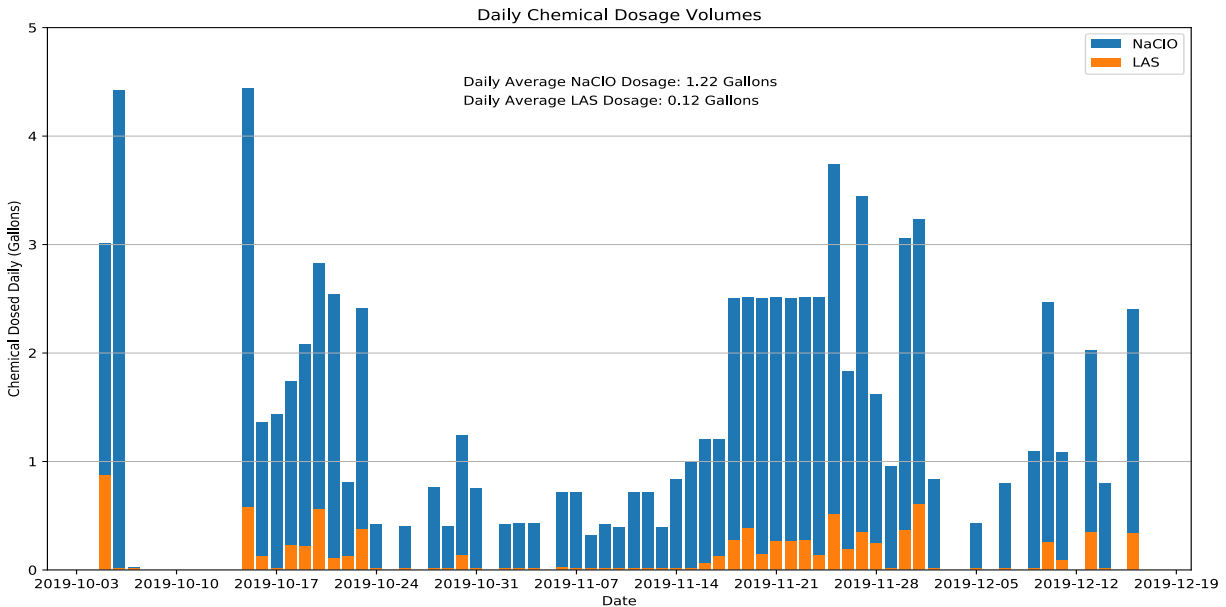


Figure 1: Graph showing the daily chemical usage of the RHQ workstation. Blue indicates 12.5% Sodium Hypochlorite was dosed and orange indicates Liquid Ammonia Sulfate was dosed.

**Figure 1-** This graph shows the average daily chemical dosing performed by the RHQ system.

Initial startup of the RHQ on October 5<sup>th</sup>, 2019 required the greatest amount of chemical dosage. Once the total chlorine residual was within the desired range, much smaller doses were needed to maintain the target residual. The RHQ dosed consistently under one gallon per day of sodium hypochlorite from October 24<sup>th</sup>, 2019 through November 13<sup>th</sup>, 2019.

Once the customer observed disinfectant residuals trending as intended, they reduced chemical dosage upstream by 30% starting November 11, 2019. This caused an increased need for chemical dosing at the RHQ location; however, the Dose Volume Limit was not adjusted upward to accommodate for the new demand from November 18-24, 2019. Once the Dose Volume Limit was set to allow higher daily doses when needed, the disinfectant residual recovered to within the target range.

Starting on December 2<sup>nd</sup>, 2019, the chemical demand again fell, this time due to less chemical needed to maintain residual within target parameters for the given water condition at the time.

Another important consideration depicted in Figure 1 shows the comparison of gallons dosed of LAS to NaClO was approximately 10% over time rather than 20% as would be the case for a 5:1 chemical feed ratio. This is because the RHQ starts dosing NaClO first to combine with any free ammonia. If an NaClO dose causes the subsequent total chlorine residual to fall below the initial pre-dose chlorine residual, the RHQ system will then dose LAS and NaClO (chloramine) until the Target Residual Threshold reaches the 2.0 mg/l set point.

## ResidualHQ® Operation Analysis Figure 2

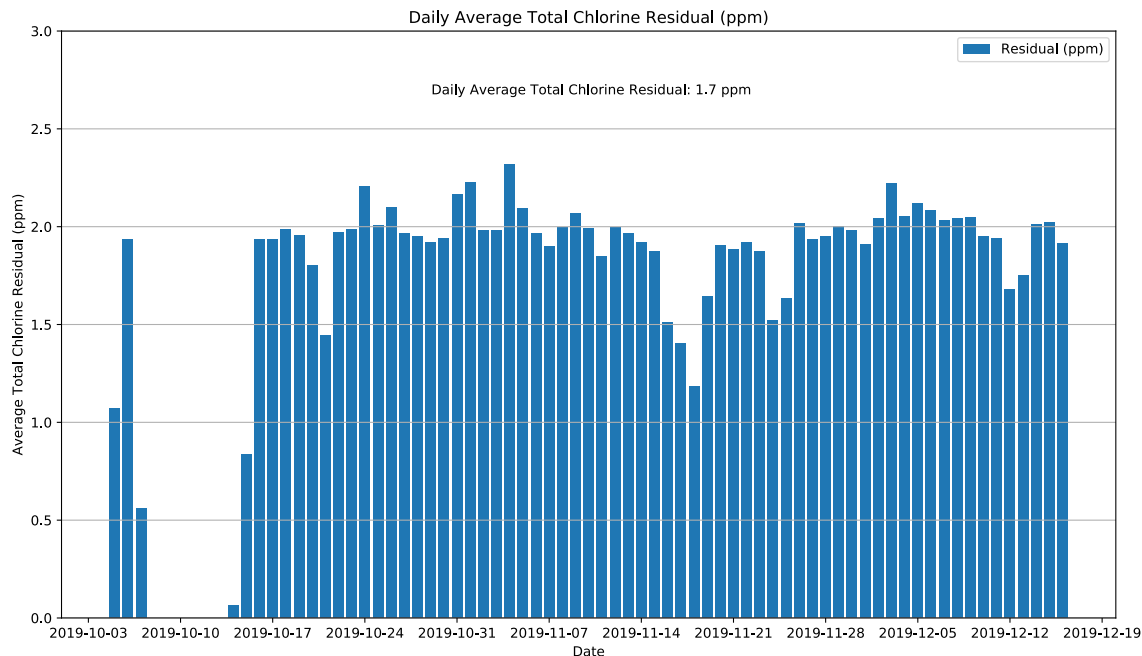


Figure 2: Graph showing the daily average Total Chlorine Residual measured by the RHQ workstation.

**Figure 2-** This graph depicts the daily average Total Chlorine Residual in the water tank. The initial startup procedures on October 5<sup>th</sup>, 2019 manually raised the residual to 2.0 mg/l; however, the RHQ needed to be turned off the following week while the customer worked through SCADA issues with their tank level sensor. Subsequently the RHQ began automated operation on October 14<sup>th</sup>, 2019 and by October 16<sup>th</sup>, 2019, the total chlorine residual was within the target range.

**Figure 2, Event 1-** On October 21, 2019, the water tower location lost power and the RHQ was off for approximately 10 hours. During this time the daily average residual went below 1.5 mg/l for the day. The RHQ was subsequently restarted by the operator.

From October 22, 2019 to November 14, 2019, the residual levels inside the water tower were consistently within the 1.8 mg/l to 2.2 mg/l total chlorine residual range.

**Figure 2, Event 2-** The RHQ began to record a drop in residual starting on November 14, 2019. This correlates with the operator reducing chemical dosage upstream. The RHQ system dosed chemical up to its pre-set daily volume limit of 2.5 gallons, which was lower than necessary value. The daily volume limit was adjusted on November 25<sup>th</sup> and by November 26<sup>th</sup>, the daily average total chlorine residual was within the acceptable range.

**Figure 2, Event 3-** On December 12, 2019, the RHQ recorded another drop in residual. This was due to an error encountered by the RHQ. The RHQ stopped dosing but continued to circulate water through the system to monitor total chlorine residual level. The NaClO was gassing off in the line from the bulk tank due to infrequent dosing. The valve was physically fine, so the system was reset through the HMI and the RHQ resumed normal operation. The issue has been resolved by changing dosing parameters, to use smaller doses more regularly.

### ResidualHQ© Operation Analysis Figure 3

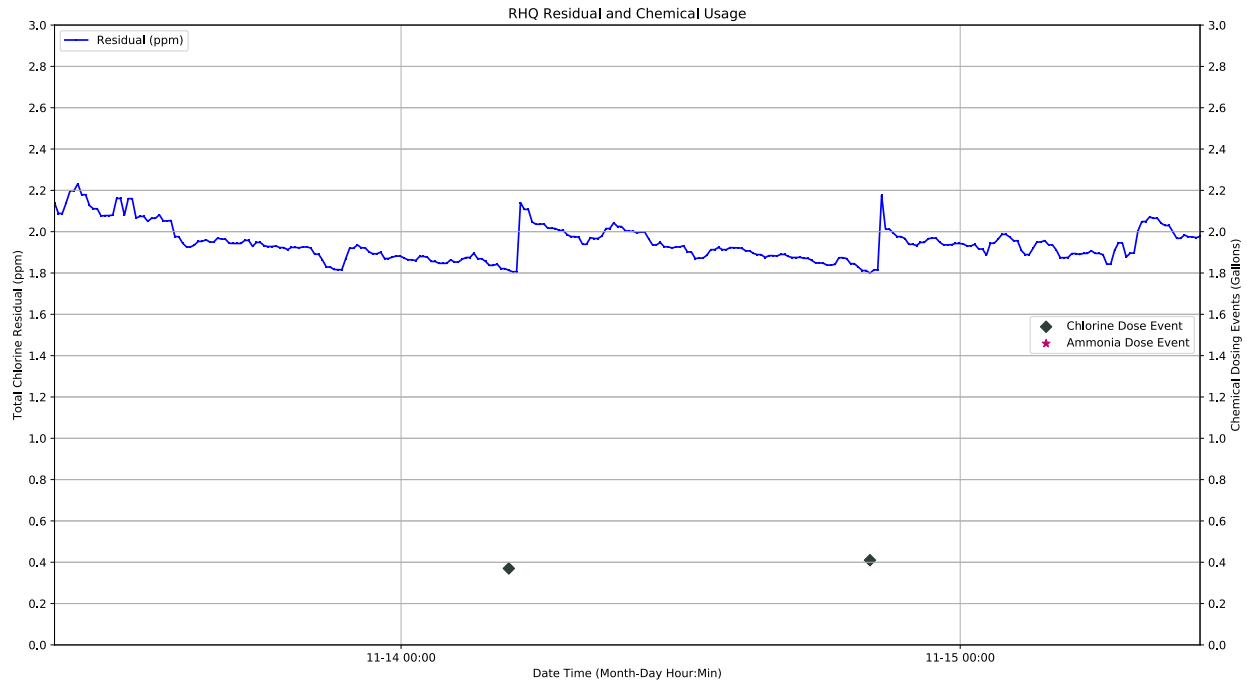


Figure 3: Two days of residual and dosing recorded by the RHQ.

**Figure 3-** This graph shows the residual trendline as recorded by the RHQ system. The system parameters were set to:

- Low Residual Threshold: 1.8 mg/l (triggers dosing)
- Target Residual Threshold: 2.0 mg/l (stops dosing)

In this particular graph, only chlorine was needed to boost the disinfectant residual.

After each dose event was completed, the RHQ waited for a set amount of time before determining if another dose is necessary (known as the Determination Wait Time). If total chlorine residual stays above the Target Residual Threshold longer than the Determination Wait Time, the RHQ transitions to “Monitoring Only” until the total chlorine residual hits the Low Residual Threshold which then triggers another dose event.

## ResidualHQ® Operation Analysis Figure 4

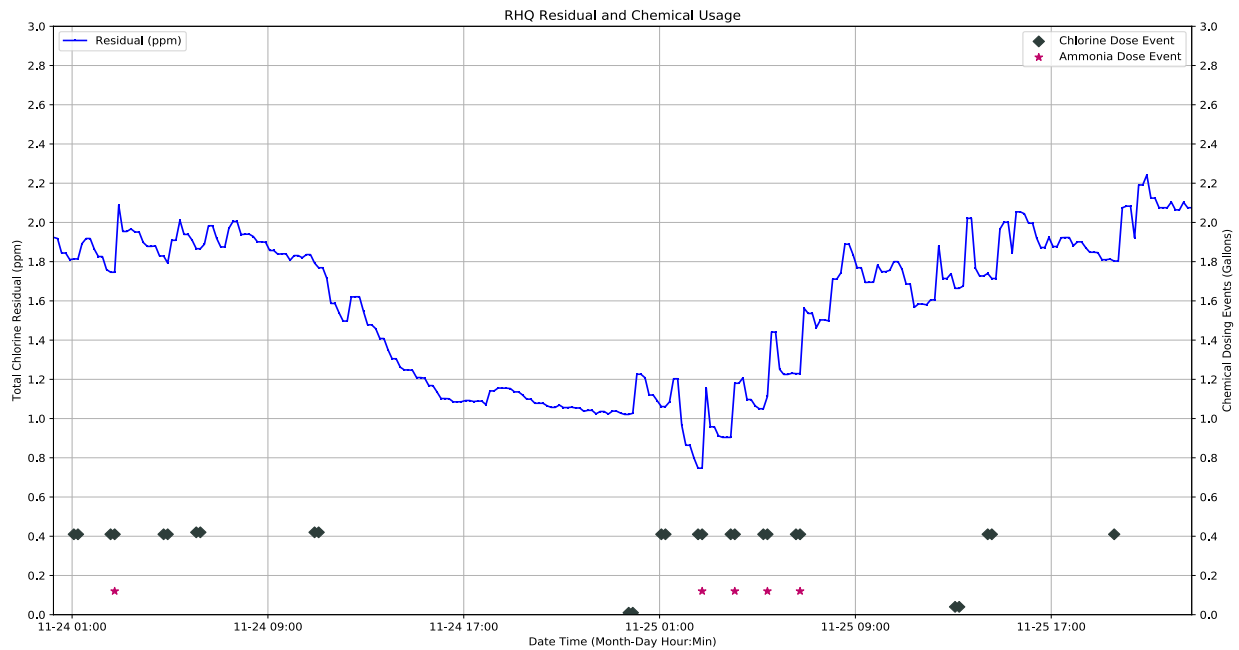


Figure 4: The residual dipped due to the daily chemical volume limit set too low. The limit was increased later in the day on 2019-11-25.

**Figure 4-** This graph details how the RHQ reacts to low residuals and how the RHQ reacts when the water no longer has free ammonia to bind with free chlorine.

It was determined the disinfectant residual trended downward because:

- The operator reduced chemical dosing up stream and
- The RHQ Dose Volume Limit was set too low.

Early in the morning of November 25<sup>th</sup>, the Dose Volume Limit was adjusted upward. When the RHQ started dosing NaClO, the total chlorine residual was observed to fall instead of rise. This indicated there was no longer free ammonia in the water to bind with the free chlorine.

The RHQ then switched over to create and dose chloramine.

This is achieved via the RHQ Pre-Mix Tank where LAS and NaClO are diluted with water, mixed, and dosed. Figure 4 shows how the incremental doses stairstep the total chlorine residual to the target value of 2.0 mg/l.

## ResidualHQ® Operation Analysis Figure 5

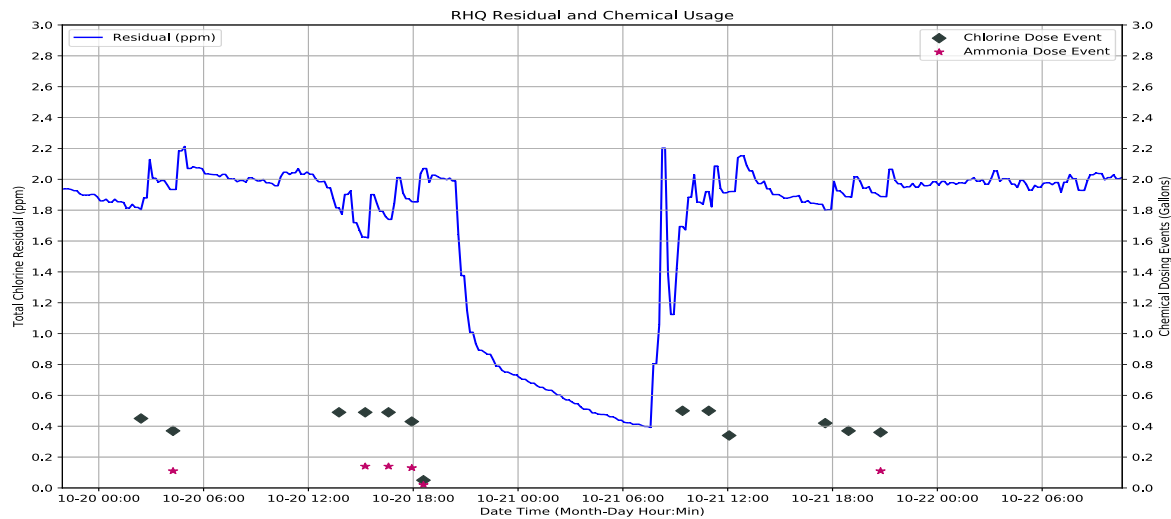


Figure 5: This graph depicts the residual level when power supply was lost to the RHQ due to a storm outage. All systems stop and the residual levels are incorrect as water is no longer flowing through the RHQ.

**Figure 5-** This graph depicts a power loss event at the RHQ site the night of October 20<sup>th</sup> due to a storm. Power was restored after a few minutes; however, the RHQ was purposefully set for manual restart (rather than automatic) after loss of power. The system was offline and not circulating for a short period of time in which a drop in total chlorine residual was observed. It is important to note the drop in total chlorine was not from water in the tank itself but from stagnant water in contact with the chlorine sensor in the flow cell.

At 8:00 am on October 21<sup>st</sup>, the RHQ was restarted and the residual can be seen to rise quickly and then fall back down. After the system restarts, the RHQ implements an “action timeout period” to allow the system to stabilize before taking any action to correct low residuals. After the action timeout, dosing resumed and the disinfectant residual recovered to above 2.0 mg/l.

### Summary

The initial RHQ field placement has been an overall success. Disinfectant residual throughout the system stayed well above the mandated level of 0.5 mg/l.

A recent report provided by the customer also indicated ATP (adenosine triphosphate) residuals are below 1 pg/ml, nitrite less than 0.01 mg/l and nitrate less than 0.1 mg/l. In comparison, the customer had issues with all three of these values the month previous to the RHQ deployment (September 2019).

RHQ safety features performed as intended including the Loss of Power and Dose Volume Limit protocols.

The operator is going to work toward reducing the amount of upstream chemical dosed by 10%. Ixom Watercare will continue to monitor the RHQ from our Dickinson, North Dakota offices to help the operator as well as further analyze & improve RHQ operation and protocols.