

# City of Memphis Maynard C. Stiles Wastewater Treatment Plant Disinfection Improvements

## Pilot Study Phase 4 Summary April 13, 2015

### Background

The objective of the full-scale peracetic acid (PAA) pilot study is to identify the best disinfection control strategy to achieve compliance with the future NPDES permit disinfection limits under varying flows and influent quality conditions. The Pilot Study Work Plan, previously developed and approved in 2014, includes a description of Dose Control Strategy, Phases of Testing, Data Analysis, Pilot Study Management, and Additional Industrial User Testing to be conducted.

The pilot is being conducted in phases; the first four include development of information on the best means of providing dose control. A fifth phase will be used to demonstrate efficacy of the final process control algorithm. Data collected during the pilot will be used to inform the final design of the dose control for the full-scale system design. This document provides a summary of the results of Phase 4.

### Phase 4: Implementation

The wastewater from the north and south sides of the plant meet and discharge into the mixing compartment at the head of the contact tank. The combined flow is split into two parallel, serpentine contact channels. Pre-disinfection water quality, including color, chemical oxygen demand (COD), and undisinfected *E. coli*, is assessed at the head of the disinfection channel that is not receiving PAA. The water quality parameters are being measured continuously on-line, during this phase are as follows:

- Color - ChemScan UV-3151 series flow-thru sensor
- COD - YSI CarboVis 701 submersible probe

PAA residuals were measured throughout the disinfection channel by three separate, Ducotest Amperometric PAA sensors, P1, P2 and P3, as shown in Figure 1. Bacterial samples were also collected at several locations throughout the basin during testing, with locations also shown in Figure 1.

Using data from Phase 1 and 2, color was selected as a parameter for dosing using a feed forward control strategy based on the quality of fit between PAA demand and wastewater color. The PAA dose during Phase 4 was determined by evaluating the data collected during Phases 1 and 2 to select a base PAA setpoint dose and adding additional PAA that is equivalent to the calculated demand from the wastewater characteristics, as shown in Equation 1. Here, the PAA demand is calculated as a function of color, as determined during Phases 1 and 2.

$$PAA_{\text{dose}} = PAA_{\text{setpoint}} + PAA_{\text{demand}} \quad \text{Equation 1}$$

In preparation for Phase 4, a new flow meter was installed on January 31 to improve the accuracy of flow measurement during the trial. Phase 4, color was continuously monitored as described above, and the chemical feed pump PLC calculated PAA demand from the measured color; this value was added to

the refined target setpoint to pace chemical feed. During the month of Phase 4 the PAA<sub>setpoint</sub> was optimized using data collected during Phase 1 and 2 testing.

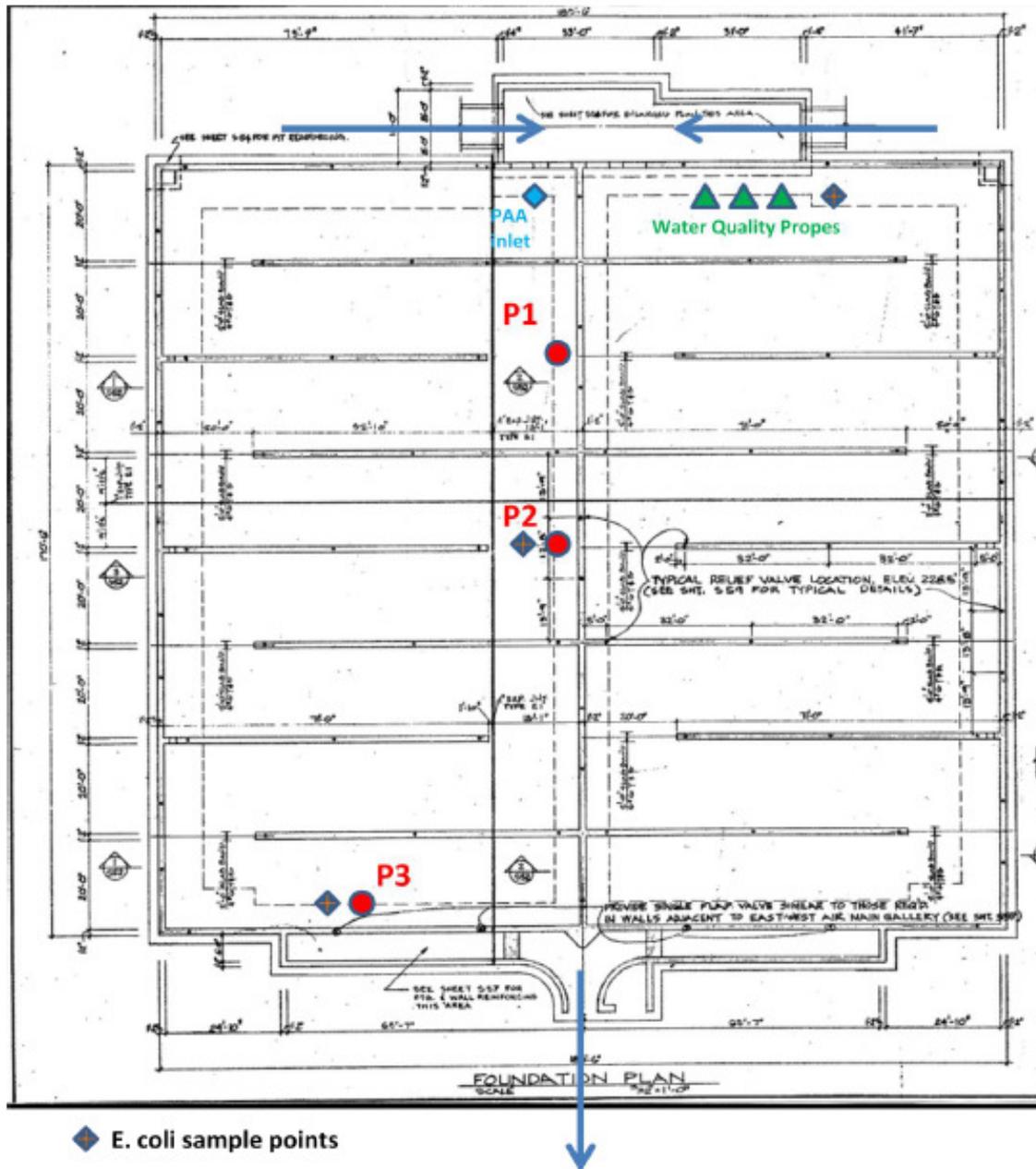
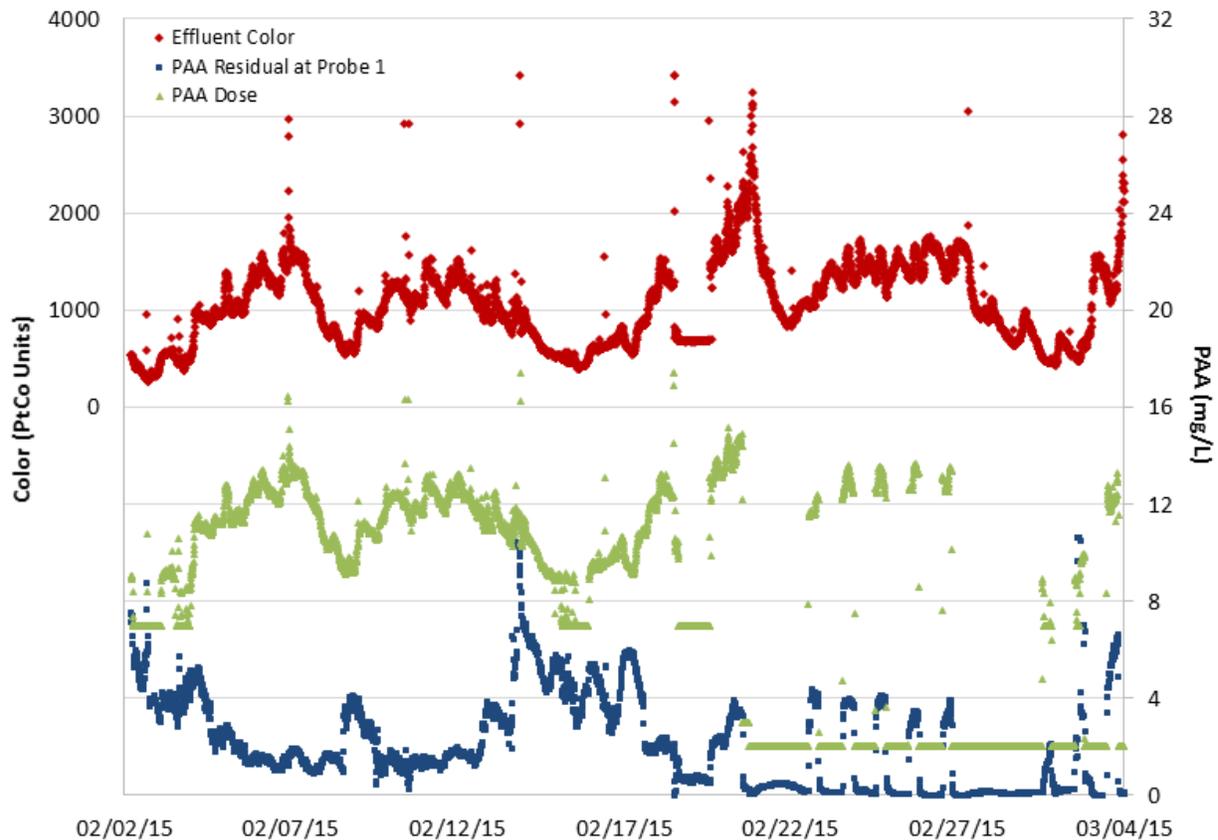


Figure 1. Water quality monitoring and sampling locations in disinfection contact tank.

### Phase 4: Results

Phase 4 was initiated on February 3, 2015 and concluded on March 4, 2015. The new flow meter provided stable and improved readings throughout the entirety of Phase 4, and as a result the flow based control was also improved. Data for PAA dose was plotted along with effluent color, and PAA residual measured at Probe 1, and is provided in Figure 2. The PAA residuals at P2 and P3 were

periodically near the detection limit of the analyzer throughout the phase and are not shown; as a result, the analysis of Phase 4 data is based on the residuals reported at P1, which are shown in Figure 3 along with *E. coli* results.

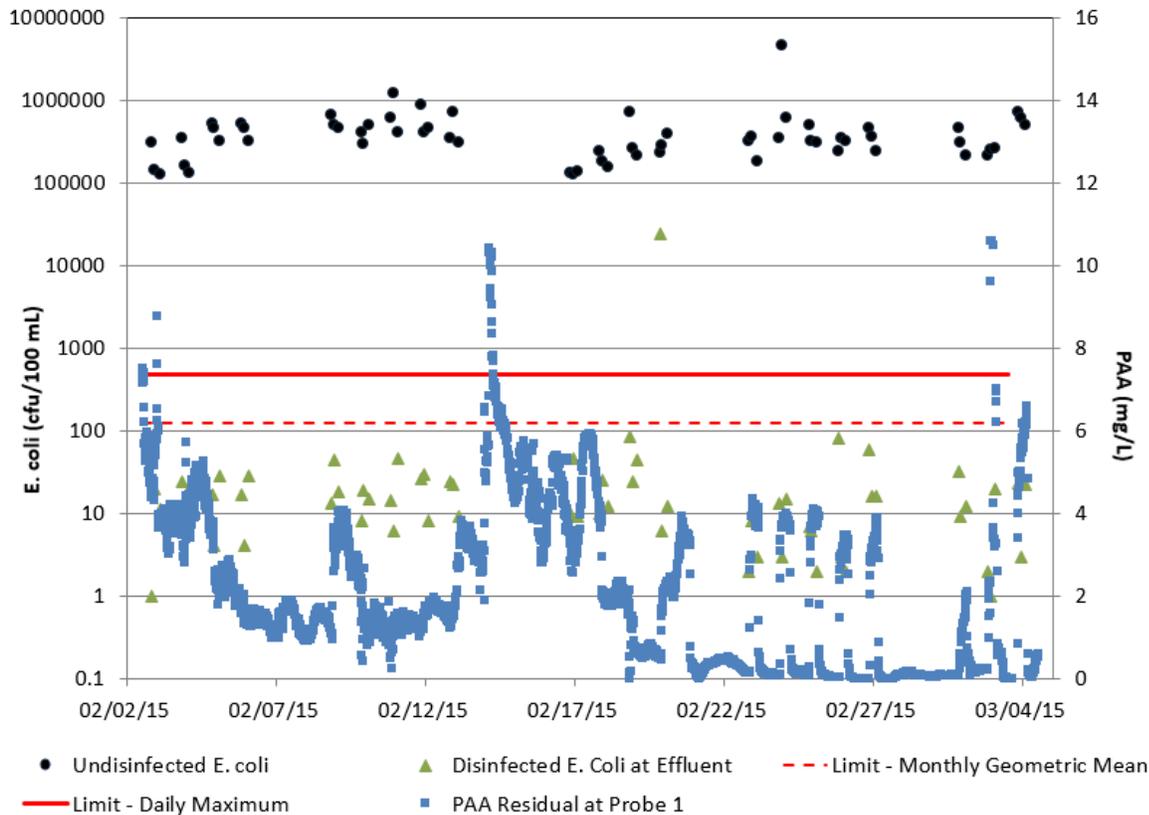


**Figure 2. Color, PAA dose and PAA residual measurements during Phase 4.**

As shown in Figure 2, there were operational disruptions in the data collection during Phase 4. The first disruption occurred late in the day on Thursday, February 19th and into the morning of February 20th, when extreme cold weather caused the effluent sample line leading to the color analyzer to freeze. As a result, color analysis and the resulting feed-forward control of PAA dosing were impaired; this is an important note and the engineering design will be developed to address this issue at full-scale.

The second disruption occurred due to the severe cold weather encountered throughout the country. This resulted in interruption of deliveries of VigorOx WWT II to the site. As a result, to prevent a shutdown of the study due to limited PAA, a PAA “conservation” program was initiated on Saturday, February 21st. The conservation program consisted of reducing the dosage of PAA into the disinfection chamber to a flow-paced 2 ppm, during periods when *E. coli* sampling does not occur (weekends and evening hours). It has been shown that this reduction in off-hour PAA usage does not negatively interfere with *E. coli* testing during the weekday sampling periods and will not impact the demonstration of PAA efficacy. Because there are no technical issues associated with this reduction in off-hour PAA usage, this will continue throughout the pilot study as a significant cost-savings to the City. Similar to the first interruption, this is an important event to note and the engineering design will be developed to

prevent this issue from occurring at full-scale by providing an appropriate storage volume onsite as well as working with the chemical supplier to provide consistent product supply.



**Figure 3. *E. coli* results and PAA residual measurements at Probe 1 during Phase 4.**

Results of the bacteria testing showed that color was an excellent feed forward parameter for managing disinfection process control. Phase 4 was completed on March 4, 2015; and as shown in Figure 3, the PAA setpoint determined from previous Phases met the 126 cfu/100 mL criteria except for during the first interruption from Thursday, February 19<sup>th</sup> and into the morning of February 20<sup>th</sup> when the sample line leading to the color analyzer froze. As a result, PAA dose control was switched to flow pace only at the baseline setpoint for PAA and the sample collected during this time did not meet the daily maximum limit. While this result did not meet the permit requirement, it does show that the dose control algorithm and that color is a highly sensitive method for managing effluent *E. coli* concentrations.

### Summary and Future Testing

Based on the results of this Phase of testing, as anticipated from data collected during previous Phases, color is strongly correlated to disinfection performance. This parameter, which was used for feed forward during Phase 4 proved to be an excellent process control parameter for managing disinfection. The next phase of testing (Phase 5) will be conducted similarly to Phase 4 where process control is based on color as the feed forward parameter. During Phase 5, which will be run for one month using the new flow meter, the optimized dose control model will be demonstrated. It is also important to note that Phase 5 testing will be conducted under the conservation program to provide a cost-savings to the City; this mode of operation does not impact the results of the PAA disinfection demonstration.