NEW Water
The brand of the Green Bay Metropolitan Sewerage District

Memorandum

TO: Tom Sigmund

FROM: Nathan Qualls

DATE: January 22, 2020

SUBJECT: Summary of the Root Cause Analysis

Background Information

NEW Water is investigating the cause(s) of the thermal excursion, as well as the performance of the monitoring and protective systems during the November 7, 2019 malfunction event. Based upon consultation with industry experts and NEW Water's general understanding of the granular activated carbon (GAC) technology, NEW Water's current and preliminary understanding of what may be the primary cause of the malfunction is as follows: Carbon bed hotspots commonly form as a result of an exothermic reaction due to moisture or contaminants adsorbing onto the carbon. These hotspots, if not properly cooled with adequate, well-distributed air flow, can lead to thermal excursions and reach temperatures that can damage fiberglass components of the GAC system or lead to a fire.

In addition, NEW Water has retained Chavond-Barry Engineering Corporation (CBE) to perform a more comprehensive root cause analysis. NEW Water expects CBE to provide NEW Water with its findings along with recommendations for possible changes for operational procedures and system monitoring and controls that will correct and eliminate the primary causes of the malfunction (Final Report). The Final Report will attempt to clarify the extent to which the following conditions (and potentially others) may have contributed to the development and inability to control the carbon bed hotspot:

- Build-up of deposits in carbon bed
- Carbon bed washing and drying operations during the maintenance outage
- Carbon monoxide and carbon bed temperature monitoring system performance

Preliminary Findings and Developments

The information provided below should be considered preliminary and may prove to be irrelevant upon further developments as the root cause analysis continues. Additionally, other factors may be discovered to be more pertinent to the thermal excursion.

Regarding build-up of deposits in the bed:

> Our preliminary findings are that the increased differential pressure in the GAC was caused by sulfuric acid salts depositing in the carbon bed. This build-up led to the carbon being washed per the CPPE process. With regards to the thermal excursion and based on communication with CPPE, the primary concern with the build-up of the acid salts is that they could lead to poorly distributed air flow which increases the likelihood that a carbon bed hotspot will not be adequately cooled. While the

build-up of deposits in the bed is of concern, it does not appear to be a 'root' cause of the thermal excursion; rather, it led to events and conditions that are more directly related to the thermal excursion.

Regarding the carbon bed washing and drying operations leading up to thermal excursion:

Our preliminary findings indicate that the drying operations that followed the in-situ washing of the carbon bed were ceased before the entire carbon bed was 'fully dried' to less than 10% moisture. Additionally, the drying process was concluded and the bed was then allowed to sit offline for almost one week with large differences in dryness in the bed (~2% in bed 1 and >30% in bed 3). This condition of very dry carbon in the vessel with very wet carbon for an extended period of time is of particular concern. GAC vessel carbon monoxide data indicates that a hot spot in the carbon may have begun forming during this period. Preliminarily, we feel that this condition is directly related to the root cause of the thermal excursion.

Regarding the carbon monoxide and carbon bed temperature monitoring system performance:

During the week of January 6, NEW Water staff performed a functional acceptance test of the GAC and the protective systems and their controls programming. A number of gaps were identified between the functional description and actual operation. These gaps were communicated to Jacobs (NEW Water consultant), Suez (overall responsibility for the fluid bed incinerator and air pollution control equipment) and Carbon Process & Plant Engineering S.A. (the GAC system provider). The parties have been reviewing these gaps in the functionality and collaborating on appropriate changes to the controls programming. Suez will be onsite during the week of January 20 to implement and test any changes. Preliminarily, we feel that the gaps in the functionality are directly related to the extent of damage caused by the thermal excursion.

Additional carbon bed temperature probes are being considered to further enhance the ability to detect hot spots throughout the GAC.

NEW Water and CBE will continue to perform the root cause analysis in an effort to get the GAC operational as soon as possible, while balancing the regulatory issues with the need to operate the GAC in a safe manner.

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