

Handed out
1/10/11

UNIT WELL NOS. 7 & 8 – IRON AND MANGANESE TREATMENT TECHNOLOGY EVALUATION

Madison Water Utility
Madison, Wisconsin

Black & Veatch Corporation
B&V Project 169092.0700
B&V File 40.0700

Black & Veatch Corporation
225 E. Mason Street, Suite 801
Milwaukee, Wisconsin 53202

December 21, 2010



Background

The Madison Water Utility (MWU) is developing a comprehensive plan to provide reliable supply of high quality water cost effectively to the City's Zone 6 – East Service Area. The Zone 6 – East Service Area is served by five wells including Unit Well Nos. 7, 8, 11, 15 and 29.

This memorandum addresses alternative treatment processes for iron and manganese removal at Unit Well Nos. 7 and 8. In particular, the evaluation included a review of previous studies performed by MWU, a performance review of the treatment system at Unit Well No. 29 and consideration of other iron and manganese removal technologies not previously considered. The concentration of iron at Unit Well Nos. 7 and 8 exceeds the Secondary Maximum Contaminant Level (SMCL). In addition, the concentration of manganese at Unit Well No. 8 exceeds the SMCL.

Overview of 2007 Pilot Testing

Pilot testing was conducted by the Madison Water Utility during January and February 2007 to identify the optimal iron and manganese removal process for Unit Well No. 29. Treatment processes evaluated were as follows:

- Conventional dual media filtration (preconditioned to establish a manganese dioxide coating) at rates of up to 8 gpm/sq ft, with provisions for preaeration and chlorine and/or potassium permanganate preoxidation.
- Manganese greensand filtration with anthracite cap at rates of up to 5 gpm/sq ft, with chlorine and/or potassium permanganate preoxidation.
- Filtration using a proprietary granular media (CalMedia GSR Plus, manufactured by Calgon Carbon Corp.) at rates of up to 10 gpm/sq ft, with chlorine and/or potassium permanganate preoxidation.
- High-rate pyrolusite filtration at rates of up to 18 gpm/sq ft, with chlorine preoxidation.
- Ultrafiltration membrane treatment, preceded by chlorine oxidation and 20 minutes of detention time.

Pilot testing demonstrated that all processes (with the exception of oxidation/membrane filtration) met the established treatment objectives. High-rate pyrolusite filtration was the recommended treatment strategy based on an evaluation of life-cycle costs.

A multi-cell high-rate pyrolusite pressure filtration system was installed at Unit Well No. 29 following completion of the pilot testing program. Eight pressure filters were provided to treat up to 1,200 gpm, and the multiple filter configuration allows for backwashing of a dirty filter using filtered water from the remaining in-service cells, thereby eliminating the need for dedicated backwash pumping equipment. The Filter Building layout can accommodate the future installation of an additional packaged filtration system resulting in a total treatment capacity of 2,400 gpm.

Treatment Performance at Unit Well No. 29

Performance during initial operation of the Unit Well No. 29 treatment system is summarized in Table 1. Data for 45 days of operation between mid-April and mid-June 2009 indicate that performance with respect to removal of iron and manganese was excellent, with finished water iron and manganese concentrations significantly less than both their respective secondary (non-enforceable) MCLs and concentrations typically recommended to ensure that water quality problems within the distribution system do not occur.

**Table 1. Performance for Unit Well No. 29 Treatment Facility
(April 16 – June 19, 2009)**

| Parameter | Average | Range |
|-----------------|---------|---------------|
| Iron, mg/L | | |
| Raw Water | 0.340 | 0.292 – 0.429 |
| Finished Water | 0.016 | 0.006 – 0.061 |
| Secondary MCL | 0.30 | |
| Manganese, ug/L | | |
| Raw Water | 185 | 161 - 202 |
| Finished Water | 2.75 | 1.1 - 12 |
| Secondary MCL | 50 | |

Treatment Technologies

The pilot testing program conducted by the Madison Water Utility in 2007 encompassed all of the commonly-considered treatment processes used for removal of iron and manganese from ground water supplies. There have been no new innovations in iron and manganese removal technologies since the 2007 pilot study at Unit Well No. 29. Other technologies, such as biological filtration, would be more expensive to implement due to the need to provide two separate sets of filters to accomplish removal of both iron and manganese. Ozone oxidation followed by either conventional granular media filtration or membrane filtration would also be more costly to implement, and use of ozone is not indicated by the presence of other contaminants which would be effectively oxidized.

Conclusions and Recommendations

The following is a summary of our conclusions and recommendations:

- The pilot testing program conducted in 2007 encompassed all of the commonly considered treatment processes used for removal of iron and manganese.
- There are other treatment technologies for iron and manganese removal (biological filtration and ozone) that were not previously considered. However, these technologies would not be economically viable.
- There have been no new innovations in iron and manganese treatment technologies since the 2007 pilot study was conducted.
- Performance of the high-rate pyrolusite filtration system at Unit Well No. 29 has been excellent.
- The use of a high-rate pyrolusite filtration system at Unit Well Nos. 7 and 8 is considered an appropriate and cost-effective approach.