July 19, 2013

Ms. Lauren Worley, Enforcement Specialist
Drinking Water Enforcement Unit
Water Quality Control Division
Colorado Department of Public Health and Environment
4300 Cherry Creek Drive South
Denver, Colorado 80246

Subject: CDPHE Enforcement Order DC-110829-1
Meadow Mountain Water Supply Company
July 19, 2013 Final Evaluation Report
Project No.: 1115.023

Dear Ms. Worley:

Meadow Mountain Water Supply Company (MMWSC) is pleased to provide the enclosed final evaluative report for the turbidity compliance effort to satisfy CDPHE's Enforcement Order DC-110829-1 dated August 29, 2011. There are two different versions of this report. As requested, Stewart Environmental have sent their original "Final Evaluative Report". We enclose a modified version of the report prepared by MMWSC which can serve as the final product as submitted to CDPHE in fulfillment of the enforcement order compliance requirements. The report addresses the facility's turbidity compliance efforts to date and includes spring run-off data, monitoring plan, cross connection control measures, BacT Sampling Plan, Operations and Maintenance Manual and Schedule and an implementation plan.

MMWSC has been working diligently with Stewart Environmental Consultants (SEC) to evaluate the issues causing the turbidity at the water plant, and we have been experiencing difficulties with this relationship in the last four months.

Prior to January 2013, the MMWSC water board had decided to prepare an RFP to solicit an engineering company to assist MMWSC in determining long term plans for our water treatment plant and distribution system. This was determined to be a necessary first step in our efforts to assist our owners in determining if there was a need to change our company status to a Special Taxing District. As a result of reviewing the SEC Final Evaluative Report, which has been sent, MMWSC is forced to now request assistance from our new engineering firm to complete the determination of a solution for the Turbidity Enforcement Order. There are several reasons why MMWSC is not in agreement with the SEC Final Evaluative Report, the main being as follows:

1. There are several inconsistencies in the reported data, specifically related to the particle size analysis;
2. There are inaccuracies in statements regarding future requirements that have not been substantiated with the MMWSC board, but simply reported from the Water Plant Operator; and
3. There are unsubstantiated statements regarding the operations of the plant and no definitive analysis has been performed to back up these statements, specifically related to filter bag changes and Sedimentation tank issues.

Enclosed in this letter are the planned next steps that MMWSC will be taking to complete our work on this enforcement order:

1. Intake Conveyance, Treatment and Distribution System Analysis by Lidstone and Associates – July 2013
2. Completion of Study and Findings Report – September 2013
3. Review and selection of recommended improvement plan option – October 2013
4. Design report and specifications submitted to CDPHE for review. Funding sources pursued. – Q1 2014
5. Final improvement plan and implementation schedule, submitted to CDPHE for approval – Q1 2014
6. Pilot study, temporary solution, or long term solution implemented by spring runoff. – March 2014

Work will continue on the Operations and Maintenance Manual, Schedule and Procedures as we determine improvements that will be required to the plant and the distribution system, so please consider this O&M manual as a work in progress.

If you have any questions regarding either of these reports or the steps that we are planning to take in the future, please do not hesitate to contact me directly.

Sincerely,

R. C Barkworth

Rachel Barkworth
MMWSC Board Member

Enclosures

Final Evaluative Report: Meadow Mountain Water Supply Company (MMWSC) Enforcement Order DC-110829-1 Compliance Efforts

Performed at:
Meadow Mountain Water Supply Company Drinking Water Treatment Facility
Allenspark, Colorado

Prepared for:

Colorado Department of Public Health and Environment (CDPHE)
Department of Water Quality

Prepared in part by:

Meadow Mountain Water Supply Company

JULY 19, 2013

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1.0 INTRODUCTION

1.1 Background

Meadow Mountain Water Supply Company (MMWSC), PWSID # CO 0270504, is a residential development-owned non-profit domestic water treatment facility in Allenspark, Colorado. MMWSC's rural domestic water supply system has been informally expanded and maintained on a need-by-need basis over the past few decades.

On August 29, 2011, MMWSC was issued CDPHE Enforcement Order DC-110829-1 for turbidity violations and other pertinent issues identified in the departments' accompanying sanitary survey. A copy of each of these documents is provided in **Attachment A (EO & Sanitary Survey.pdf)**. MMWSC's compliance efforts include the following items:

- Evaluation of turbidity issues in spring run-off and determination of appropriate treatment upgrades or improvements that will bring the system into compliance.
- Resolve all deficiencies identified during the August 2011 CDPHE Sanitary Survey.
- Complete and submit documentation requested for the compliance with the enforcement order.
- Ongoing operational improvements.

1.2 Purpose

Per CDPHE Enforcement Order DC-110829-1, the treatment system utilized by MMWSC for its drinking water treatment process is required to be upgraded, improved, or better controlled or maintained to ensure compliance with CDPHE's treatment technique limits for turbidity, specifically addressing the seasonal high turbidity levels typically experienced each spring.

System observation and data collection was performed by Stewart Environmental and MMWSC in an effort to identify the source of and further characterize the turbidity.

This report documents the findings of the study and the evaluation conducted on the system between October 2011 and June 2013. The document also illustrates the compliance efforts made by MMWSC for all enforcement order-related issues, including turbidity, monitoring plan, operations and maintenance manual, BacT Sampling Plan and cross-connection control measures. This report contains the water quality results, result discussion, next steps, and an implementation schedule for system upgrades. Laboratory results are also attached.

2.0 WORK PERFORMED

2.1 Enforcement Order Compliance Tasks

Per the CDPHE Enforcement Order Number DC-110829-1, MMWSC has taken action to investigate the source of the turbidity violations in order to determine the most appropriate actions to bring the system into compliance. As required by the Enforcement Order, MMWSC took immediate actions to comply with Colorado Primary Drinking Water Regulations, 5 CCR 1003-1, Articles 1 through 13, with the goal of achieving long-term compliance. MMWSC retained a professional engineer, Stewart Environmental (SEC), to evaluate and recommend turbidity treatment technologies, distribution system and operational improvements and/or upgrades, or alternate water sources to MMWSC to ensure compliance with CDPHE's treatment technique limits for turbidity.

MMWSC anticipates the following proposed schedule, which is intended to accommodate the long term goal of an optimized, robust turbidity reduction system and the short term requirement of compliance during the Spring 2014 runoff event.

Preliminary Improvement Plan Schedule	
Completion of study and findings report by selected engineer.	October 2013
Review and selection of an improvement plan option.	October 2013
Drawings and specifications submitted to CDPHE for review. Funding sources pursued.	1Q 2014
Final improvement plan and implementation schedule, submitted to CDPHE for approval.	1Q 2014
Pilot study, temporary solution, or long term solution implemented by spring runoff.	March 2014

Upon selection of an improvement plan option MMWSC will submit documentation to CDPHE noting operational updates. All Final Design Plans and Specifications, per 5 CCR 1003-1, will be submitted for review and approval by CDPHE in accordance with the State of Colorado Design Criteria for Potable Water Systems. Pending the chosen treatment technique, Final Design Plans will include commitment dates for the following items:

- The date MMWSC will begin construction/implementation of the system improvements.
- The date MMWSC will achieve substantial completion of the system improvements.
- The date MMWSC will complete construction/implementation of the system improvements.

2.2 Water Quality Analysis

From November 2011 through June 2012, baseline water quality data was collected, spring run-off sampling was conducted, and a system assessment was performed. Baseline water data was collected in November 2011, February 2012, and March 2012. Peak run-off sampling was conducted in April 2012. However, peak run-off resulted in compliant turbidity values. The low turbidity was attributed to the minimal snowfall seen during the winter of 2011-2012. Therefore, the water quality analysis was deemed incomplete. For this reason, CDPHE granted MMWSC a one-year extension for the run-off evaluation. High turbidity sampling took place in the spring of 2013. See Water Quality Results and Discussion in Sections 3.0 and 4.0, below.

2.3 Monitoring Plan, BacT Sampling Plan, Cross Connection Control, and Other Enforcement Order Requirements

In accordance with CDPHE requirements, a monitoring plan and supporting O&M documentation for the treatment facility have been formalized and are submitted with this report as attachments. BacT Sampling Plan and Cross Connection Control Program were submitted to Jorge Delgado and Lauren Worley separately, on May 1st, 2013. Pictures showing the resolution of the concerns about cross connection related to the air relief valve and overflow in the treatment facility were sent to Jorge Delgado on April 4th, 2013. Verbal approval was obtained from Jorge regarding this issue. All cross connection-related items were granted verbal approval by Jorge Delgado on June 10, 2013 Lauren Worley confirmed receipt of the BacT Sampling plan on May 2nd, 2013.

3.0 WATER QUALITY RESULTS

3.1 Results for Fall 2011 through Spring 2012

This water quality data was obtained between the fall of 2011 and the spring of 2012. The results of peak turbidity sampling are provided in **Attachment C (Lab Reports.2013.pdf)**.

The winter of 2012 saw limited snowfall in Allenspark, thus resulting in lower run-off flow rates. However, the resulting flows showed representative water quality results for most parameters.

- Turbidity during peak run-off was detected (detection limit = 0.5 nephelometric turbidity unit [NTU]) at 1.2 NTU. Due to scant winter snowfall, the spring 2012 peak run-off event did not yield representative flows or turbidity values. As a result, the finished water turbidity levels were in compliance.
- Color was not detected (detection limit = 5 color unit [CU]) in baseline sampling events. However, color ranged from 10 to 18 CU throughout the treatment chain during the peak runoff event.
- Alkalinity levels range from 12.3 to 13 ppm. Typical surface water alkalinity may vary from 5 ppm to several hundred ppm. Hardness ranged from 11.5 to 13.5 ppm. All water is soft and could promote leaching of metals.
- The pH was stable between 7.35 and 7.51; this range is conducive to chlorination, but not conducive to pipe corrosion (in the low pH range) or scale accumulation (high pH) on the pipes.
- Electrical conductivity (EC) results were low, ranging from 27.5 dS/m to approximately 29.6 dS/m during the high runoff event.
- Iron concentrations range from 0.039 to 0.050 ppm (detection limit = 0.01 ppm) throughout the system during the peak run-off sampling. The EPA secondary standard is 0.3 ppm, and finished water appears to comply. The levels experienced during high runoff are not expected to add color to finished water.

3.2 Results for Spring 2013

Sampling was performed on April 30, 2013, May 21, 2013, and June 25, 2013. In the month of May, finished water showed turbidity levels of 1 NTU or greater. Peak runoff sampling was performed on May 21, 2013, and may be viewed in **Attachment C**. All water quality results are summarized below:

- Turbidity was detected (detection limit = 0.5 nephelometric turbidity unit [NTU]) in sampling events. In April, turbidity ranged from 0.9 to 2.2 NTU throughout the treatment chain during the peak runoff event. In May, turbidity ranged from 2.0 to 2.8 NTU. In June, turbidity ranged from less than 0.5 NTU to 2.5 NTU. However, the finished water samples were in compliance during both April and June.
- During the high turbidity runoff event, color was not tested until 4-7 weeks after samples were collected, which far exceeds the 48-hour hold time for the method. pH analysis was not conducted at the time of testing for comparison to the pH at the time of sampling. These results were disregarded.
- Alkalinity levels range from 15.2 to 17.7 ppm for the May sampling event. Typical surface water alkalinity may vary from 5 ppm to several hundred ppm. Hardness ranged from 5.88 to 7.14 ppm. All water is very soft and potentially could promote leaching of metals.
- The pH was stable between 6.21 and 6.64 for the May sampling event; this range is conducive to chlorination, and may also lead to pipe corrosion (in the low pH range) due to the low alkalinity values and softness of the water. The results of the upcoming lead and copper monitoring will provide insight to corrosion concerns.

- Electrical conductivity (EC) results were low, ranging from 14 µmhos/cm to approximately 25 µmhos/cm during the high runoff event.
- Iron concentrations range from <0.01 to 0.081 ppm throughout the system during the peak run-off sampling in May The EPA secondary standard is 0.3 ppm, and finished water appears to comply. The levels experienced during high runoff are not expected to add color to finished water.
- The April 30, 2013 and May 21, 2013 sampling events included particle size distribution analysis. Particle loading was too small to perform analysis on any water sample. Clarifier sludge samples did yield results with particles ranging from less than 5 microns to greater than 800 microns.

4.0 DISCUSSION OF WATER QUALITY FINDINGS

The 2013 spring run-off flows provided representative turbidity results for the sampling and analysis. The April sampling event shows final turbidity readings at 1 NTU. This value is within the permitted limit. The May sampling event on May 21, 2013, corresponding with peak run-off, showed intake turbidity values of 2.0 NTU and 2.2 NTU. Turbidity values continued to climb through the plant, eventually reaching 2.8 NTU at the finished water. This increase may be due to a few factors: 1) the short-circuiting of the sedimentation basin, 2) concentrated flow from the sedimentation basin influent line re-suspending settled particles, and/or 3) the possibility that particles smaller than the filter bag pore sizes are becoming concentrated and eventually breaking through the filters. Additionally, there may be particle accumulation and loading originating within the intake conveyance pipes and/or the clearwell. Plant daily logs show that the system was out of compliance on eight of the 31 days in May. The plant daily logs indicate that peak turbidity of 3.72 occurred on May 18, 2013.

The April and May sampling events included particle size distribution analysis. Particle loading was too small to perform particle counts on any waters except the sludge sample taken from the bottom of the clarifier. Sediment samples from the bottom of the clarifier showed particles ranging from less than 5 microns to greater than 800 microns on both occasions. The data from these analyses are included in **Attachment B**. Particles contained in the sediment of the settling basin are expected to be larger than those which pass through the basin, and are not considered characteristic of the particle loading in the filters. The water column analysis was deemed inconclusive by the Phillips Laboratory, and further particle size distribution analysis was abandoned (Attachment B).

The June sampling event showed intake turbidity values of 2.5 NTU and 0.5 NTU. However, the final filter effluent turbidity was within compliance at less than 0.5 NTU.

While color is present during high runoff events, the presence of color does not interfere with turbidity results as the turbidimeter (Hach 2100P) corrects for interferences from color and/or light-absorbing materials and compensates for fluctuations in lamp intensity. The accuracy of the turbidimeter was further verified by confirmation turbidity testing through SEC laboratory. Iron does not appear to be contributing to color.

The pre-filtration bag filter system consists of the two 3M cloth bag filters, set up in parallel with initial 1 µm pore size equivalency, which has likely increased with washing, followed by two 3M cloth bag filters in series with initial 0.5 µm pore size, which has likely increased with washing. The final filtration process entails three 2 to 3 µm Strainrite HPM99-CCX-2-SR Final Filter Bags and vessels in parallel, all utilizing the AQC-1 Compression Devices. Particles smaller than 2 to 3 um likely pass through the filters and contribute to finished water turbidity levels. Unfortunately, as previously noted, particle size analyses were inconclusive.

In May 2009, CDPHE granted MMWSC temporary approval for the use of the three existing Strainrite vessels with the Strainrite HPM99-CCX-2-SR Final Filter Bag (with AQC-1 Compression Device). CDPHE-accepted bag filtration

technology requires either an upgraded prefilter (Strainrite HPM99-CC-2-SR Prefilter) or a Strainrite Aqua-Maxx prefilter and final filter system, (Strainrite is not recommending Aqua-Maxx at this time[1]). MMWSC has the option to upgrade to a new final filter while using the current final filtration system as a pre-filtration system. However, given the nominal pore size threshold of 0.5 um for current Strainrite bag and cartridge filtration products, this is unlikely to capture the smallest particles suspected of contributing to turbidity during the spring runoff event. SEC recommended limited improvement options without cost estimates or decision making criteria. Those options include the following:

> Quote: "the use of microfiltration, polymeric membranes, and/or upgrading the existing bag filter system to meet the CDPHE-approved Strainrite products with a possible media filter. If chosen, microfiltration or polymeric membranes would replace the existing pre-filter. However, the system infrastructure must be further evaluated to determine the best options for plant upgrades with additional treatment capacity. Stewart Environmental has also recommended the potential addition of chemical pre-treatment prior to sedimentation; however this is not the primary recommendation, due to the cold water, low alkalinity, and low hardness waters along with the low temperatures. Stewart Environmental believes that the cold water temperatures and limited reaction time in the sedimentation basin would not yield optimal conditions for chemical addition. To achieve adequate flocculation, large quantities of coagulants would likely be required; hence incurring substantial operations and maintenance expenses for the facility. This method would also likely require a higher classification of an operation (Class B or A Operator License) that currently operating the facility."
>
> Quote: "Microfiltration would utilize a membrane system that would require minimal operation and maintenance costs and would potentially avoid the addition of chemicals. The membrane filtration would provide absolute pore size exclusion and would thus achieve consistent removal. This option would have the highest capital cost. However, the extremely low operation and maintenance costs would pay for the system over time. There are two types of membranes: (1) polymeric and (2) ceramic. The polymeric membranes will likely have a life span of approximately 3 to 5 years. These membranes have a lower initial cost, but due to membrane replacement, they can have a higher life cycle cost. The ceramic membranes have at least a 20-year lifespan and would not require recurring replacement costs seen with other filtration options.
>
> The third option, upgrading the existing equipment to meet CDPHE-approved use of a Strainrite bag filter system, would offer the lowest capital cost of the recommended options and would operate similarly to the Allenspark Drinking Water system. However, the recurring bag filter replacements would continue and would not decrease in price. Dennis Smith of ProWest, the Strainrite representative, recommended that MMWSC also implement a media filter with polymers. Dennis indicated that the bag filters themselves would not likely achieve the required turbidity reduction without the media filter and polymer. However, due to the changing nature of water conditions and water temperatures, this option may not guarantee the required turbidity reduction at all times. If this option is chosen, the MMWSC treatment facility will need to take the appropriate time to evaluate the optimum amount of polymer to achieve necessary treatment. For this reason, operation and maintenance costs, including polymer use, cannot be accurately calculated prior to use.
>
> A fourth option of chemical treatment may also be utilized. Prior to the sedimentation basin, polymers may be added to optimize the settling of solids. To determine the most appropriate polymer, on-site jar tests may be conducted. However, this treatment option would not be most readily recommended due to the experimentation required for polymer use determination. Polymers would require trial and error efforts to

[1] Personal conversation with Dennis Smith, ProWest Filtration, June 13, 2013.

determine the required addition. These dosing rates would also vary seasonally, particularly during spring run-off events. Also, the cold water temperatures and limited reaction time in the sedimentation basin would likely reduce the effectiveness of chemical pre-treatment."

These recommendations lack objective comparison criteria by which to make informed decisions. Due to the MMWSC's need for a comprehensive, objective decision making process, the Board has been forced to request assistance for the continued work required on the Turbidity Enforcement Order from their newly hired engineers as a result of their RFP solicitation that they undertook as a completely separate process, See Attachment F.

5.0 OPERATIONAL RECOMMENDATIONS AND IMPROVEMENTS

Due to suspected and/or known sediment accumulation in the influent piping, sedimentation basin, and the finished water clearwell, the MMWSC treatment facility will be implementing a new cleaning and pipe flushing regimen. MMWSC has been improving the operations and maintenance procedures, working with a new distribution operator, and beginning a pipe flushing schedule, starting with the hydrants. A pool-cleaning filter system has been purchased for the sedimentation tank to reduce the potential for sediment build-up and subsequent transport. Furthermore, MMWSC has re-designed the sedimentation basin influent pipe to ensure near-laminar flow into the influent chamber (1st chamber) of the sedimentation basin. The influent pipe historically concentrated flow into the bottom of the 1st chamber thereby re-suspending sediment. Measurements were taken before and after this re-design (after plant stabilization), and turbidity levels experienced a 40% reduction through the sedimentation basin.

Short-circuiting in the sedimentation basin is still occurring, and it appears that the accumulations of particles in this tank are further contributing to turbidity. The gap in the tank is currently retrofitted with a board residing in the gap. MMWSC is currently deciding how best to temporarily prop up the bottom of the tank in order to fully support the tank and prevent sagging.

6.0 SUMMARY

While the water quality study and analysis eliminated specific concerns and hypotheses (i.e., color, iron, or manganese problems), the main questions of turbidity source and characterization have been left largely unanswered. The turbidity assessment did reveal some needed operational improvements. MMWSC is left making the necessary assumption that the filtration system is likely inadequate, and ultrafine particles may be disproportionately contributing to turbidity loading in the system.