Results of the

WATER TREATMENT ASSESSMENT

at the

Heavener Utility Authority
Water Treatment Plant
PWSID OK1020101

Heavener, Oklahoma

Performed by:

Oklahoma Department of Environmental Quality
Water Quality Division
Oklahoma City, Oklahoma
August 28, 2019

Site Visit Information

Mailing Address:

Heavener Utility Authority (Authority)
906 W Avenue I
Heavener, OK 74743

Date of Assessment:

August 28, 2019

City of Heavener Personnel:

City Manager…………………………………………………………………………..Cody Smith

Veolia Personnel:

Project Manager…………………………………………………………………………..Tim DeWitt
Former Project Manager………………………………………………………….Donald Martin
Operator……………………………………………………………………...…William Curd
Operator……………………………………………………………………..…Forrest Turner

Oklahoma Rural Water Association Personnel:

Field Operations Manager……………………………………………………..…Steve Wheeler
Project Manager……………………………………………………...…………….Doug Hall

WATER TREATMENT ASSESSMENT TEAM MEMBERS

Department of Environmental Quality (DEQ)
Personnel:
Trey Peterson
Steven Hoffman
Candy Thompson
Rachel Brookins

Oklahoma DEQ
PO Box 1677
Oklahoma City, OK 73101-1677
(405) 702-8100

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EXECUTIVE SUMMARY

On August 28, 2019, a team of DEQ engineers visited Heavener Utility Authority (Authority) to assess the performance of the water treatment plant (WTP). Over fifty (50) performance factors were evaluated. Sixteen (16) were identified as limiting plant performance. These performance-limiting factors were identified based on the results from operator interviews, a WTP inspection, special studies, and sample results. There were nine (9) level "A" factors, which signify a major effect on a long-term repetitive basis. The two highest-ranking "A" factors were the limitations on the filter backwash process and concerns about the accuracy of the turbidity data reported on the monthly operating reports (MORs). A review of MOR data also showed that the Authority only met the secondary standard for manganese fifty-seven (57) percent of the days from June 2018 through May 2019, suggesting that manganese leaving the WTP was a contributing factor in the discoloration of water in some customer's taps. In addition, a major unit process capacity assessment showed the Authority's clarifiers were undersized to meet the current maximum daily flow rate. Previous water loss audits performed by DEQ found concerning amounts of water loss in the Authority's distribution system. On September 3, 2019, chlorine residual samples were taken by DEQ, which indicated an adequate free chlorine residual throughout the south side of the distribution system. While investigating a complaint on September 10, 2019, however, DEQ found inadequate chlorine in the Authority's distribution system.

INTRODUCTION

Surface water treatment plants are designed to take raw water of variable quality and produce a high quality finished water on a consistent basis. Microbial pathogens, including protozoan parasites, bacteria, and viruses, can be physically removed as particles in the flocculation, sedimentation, and filtration processes or inactivated in the disinfection process. Multiple treatment processes are provided in series to remove turbidity and to remove and/or inactivate cysts and other microorganisms. Each treatment process represents a barrier to prevent the passage and survival of cysts and other microorganisms through the plant into the water supplied to the public.

Optimized goals for the WTP include producing a finished water turbidity of ≤0.1 Nephelometric Turbidity Units (NTU) for at least 95 percent of the readings and settled water turbidity of ≤2.0 NTU for at least 95 percent of the readings, based on raw water turbidity. Another goal for the WTP is to produce finished water meeting the secondary standard for manganese, ≤0.05 milligrams per liter (mg/L). The objective of the assessment was to determine what factors are limiting the WTP from meeting these turbidity and manganese goals. The performance limiting factors are laid out in the Environmental Protection Agency's (EPA*) Optimizing Water Treatment Plant Performance Using the Composite Correction Program Handbook.*

HISTORICAL DATA

Turbidity

Turbidity data from MORs was analyzed utilizing the maximum daily combined filter effluent (CFE) values from June 2018 through May 2019. This data appears in Figure 1. The maximum daily finished water turbidity data does not meet the optimized goal of 0.1 NTU or less 95 percent of the time. The regulated value for finished water turbidity is 0.3 NTU or less for 95 percent of all of the required monthly readings. The maximum daily finished water turbidity data is meeting the regulated requirement of 0.3 NTU or less 100 percent of the time. However, the CFE turbidity data caps at 0.3 NTU, as shown in Figure 1.

In addition, beginning in October 2018, values are rounded to the nearest tenth. Therefore, it is unknown if the data submitted is an accurate representation of CFE turbidity for the specified timeframe. Also, the CFE turbidity data from the supervisory control and data acquisition (SCADA) system could not be accessed, and DEQ personnel could not verify the data or compare it to MOR values.

Individual Filter Effluent (IFE) data could not be obtained. Therefore, IFE data could not be reviewed during the specified timeframe. Regulations require IFE data be monitored and recorded every fifteen (15) minutes that a filter is in service. It could not be verified that this requirement has been met.

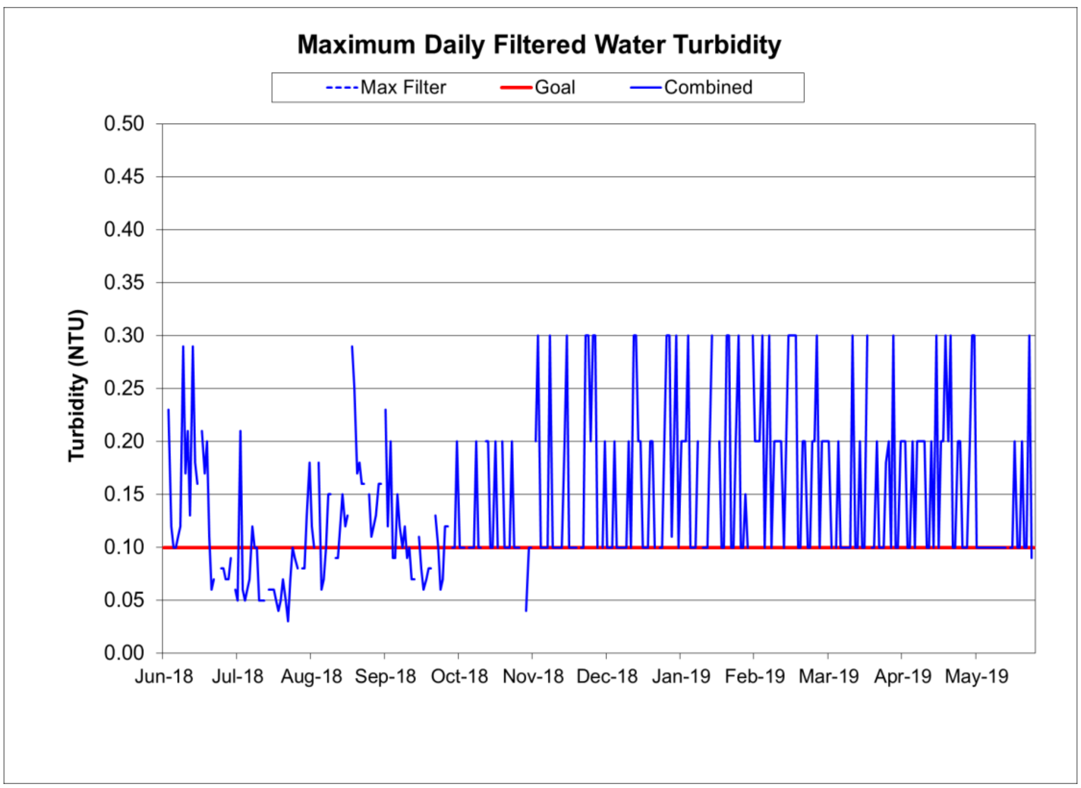

Figure 1: Maximum daily CFE turbidity values reported in the Authority's monthly operating reports

Manganese

EPA has not set primary drinking water standards for iron and manganese, but it has set guidelines because they can cause nuisance and aesthetic effects in drinking water. The secondary maximum contaminant levels (MCLs) for iron and manganese are 0.3 and 0.05 mg/L, respectively. Manganese intake from drinking water is normally substantially lower than intake from food, and there is little data to suggest that oral exposure to manganese has toxic effects. However, manganese has been monitored as part of the Unregulated Contaminant Monitoring Rule and has been placed on the Contaminant Candidate List for a possible future primary MCL.

Currently, the Authority takes daily raw and finished manganese samples and reports the data on its MOR. Figure 2 uses MOR data from June 2018 through May 2019 and shows the percentage the WTP meets the secondary standard during the month for manganese. During the entire period, the WTP's finished water met the secondary standard an average of fifty-seven (57) percent of the time.

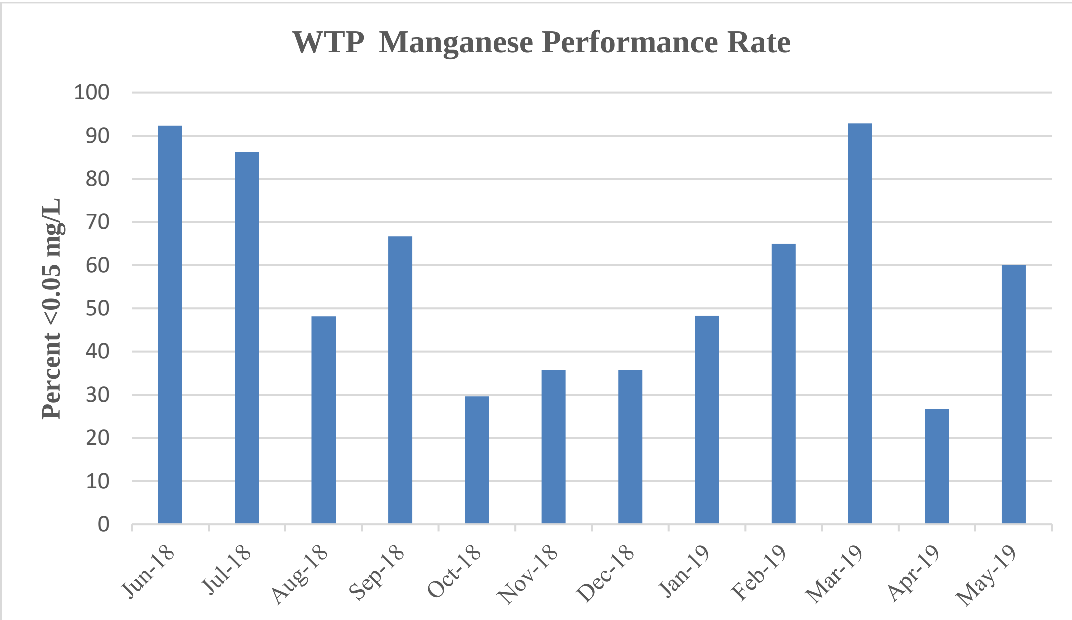

Figure 2: The percentage of days in each month the Authority meets the secondary standard for manganese

According to Figure 2, the performance rate for removing manganese decreased significantly in cooler months. October 2018 and April 2019 were the two worst-performing months in the last year. The average manganese concentration in the raw water was also the highest in these two months, demonstrating inadequate treatment processes for manganese removal.

FACILITY INFORMATION

The Authority's WTP supplies drinking water to the residents of the City of Heavener (population of 3,300) and OK Foods. Figure 3 shows a schematic of the plant.

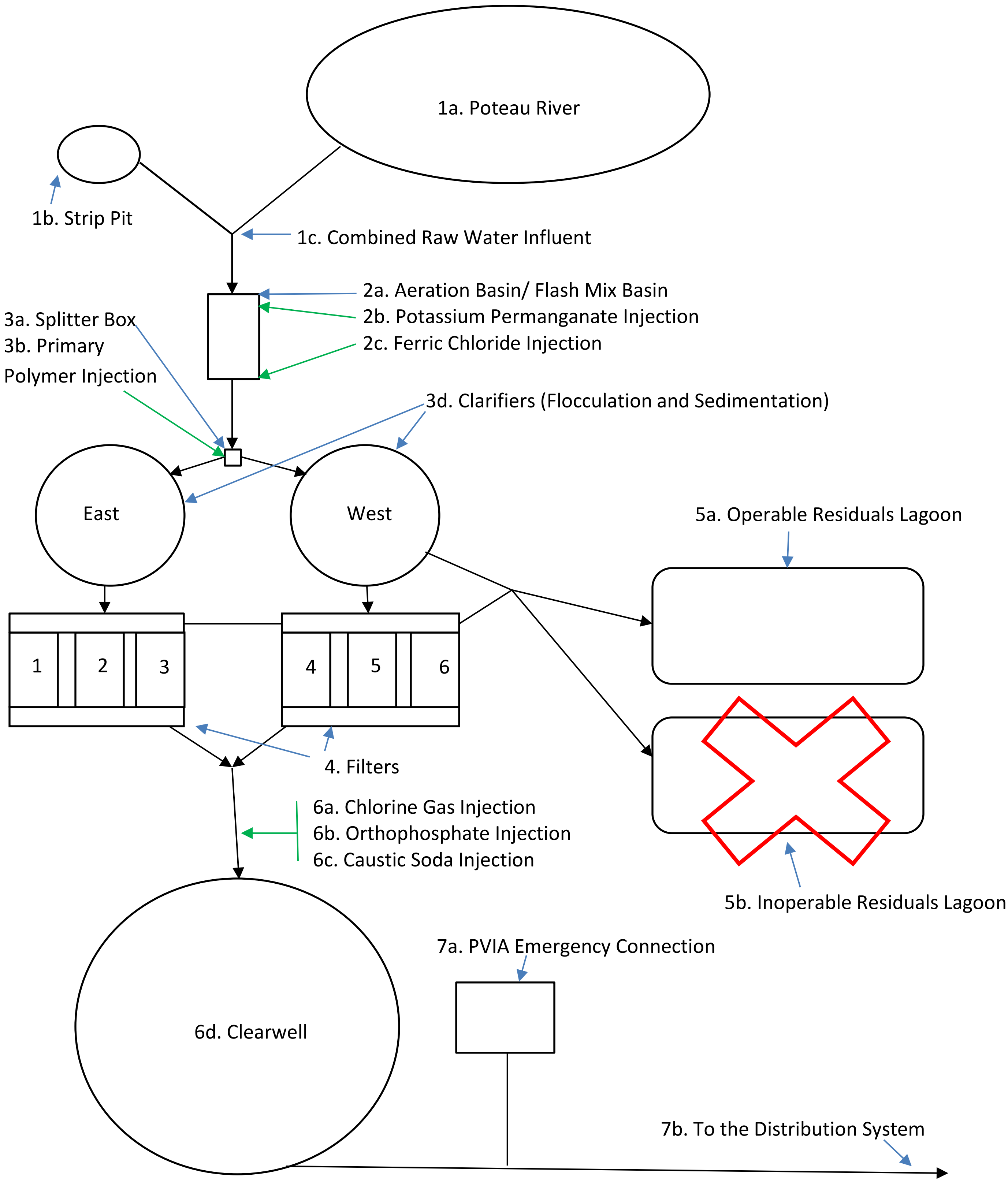

Figure 3: The Authority's WTP Schematic

WTP Plant Process Overview

The water treatment system includes the following treatment process units and chemical additions:

- An intake on the Poteau River and an intake on the East Reservoir, locally known as the "strip pit". The two sources are blended before reaching the WTP.
- Ferric chloride and potassium permanganate are added at the aeration/flash mix basin.
- A primary polymer is added to a splitter box before water enters the two clarifiers.
- Two clarifier units:
    - Two (2) flocculation zones, the east clarifier measuring 10' across and 8' deep and the west clarifier measuring 12.5' across and 8' deep.
    - Two (2) sedimentation zones, the east clarifier measuring 50' in diameter and 14' deep and the west clarifier measuring 50' in diameter and 12' deep.
- A secondary polymer can be added when needed before water enters the filters.
- Six (6) multi-media filters, measuring 10' by 15' each.
- Two (2) discharging residuals lagoons for clarifier residuals and filter backwash water. One of the lagoons is inoperable.
- Chlorine gas, orthophosphate, and caustic soda are added before the clearwell.
- The clearwell is 795,300 gallons. At the low operating volume of 6', the volume within the clearwell is 318,100 gallons.
- The Authority has an emergency connection with the Poteau Valley Improvement Authority.

SPECIAL STUDIES

Iron, Manganese, and pH Profiles

Purpose – To assess the effectiveness of major unit processes at removing iron and manganese.

Description – During the assessment, iron, manganese, and pH samples were taken before and after each major unit process and analyzed at the State Environmental Laboratory. Samples were taken from the Poteau River, "strip pit", combined raw water tap, splitter box, after the west clarifier, CFE, and finished water.

Findings – The secondary MCLs for iron and manganese are 0.3 and 0.05 mg/L, respectively. Iron concentrations above 0.3 mg/L can cause reddish brown colored water, and manganese concentration above 0.05 mg/L can cause blackish colored water. By taking iron and manganese samples before and after each major unit process, the removal of iron and manganese by that unit process can be determined. Figure 4 shows the results from the iron samples, and Figure 5 shows the results of the manganese samples taken during the assessment.

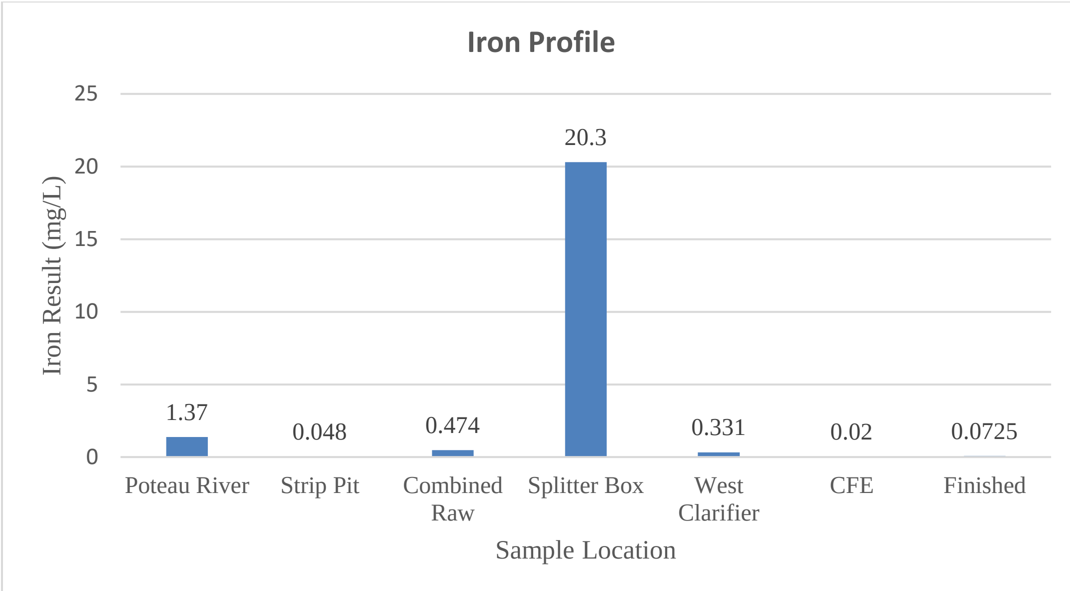

Figure 4: Iron samples from the Heavener WTP major unit processes on August 28, 2019

According to results, the WTP removed 84.7 percent of iron present in the combined raw water. The finished water iron concentration was 0.0725 mg/L, which is one fourth of the secondary MCL for iron. The concentration of iron from the Poteau River water was approximately 28 times higher than the concentration from the strip pit. The iron concentration spiked in the splitter box, which is likely caused by the addition of ferric chloride before the splitter box. Ferric chloride is used at the WTP to lower pH to increase organic removal. The results show that most of the iron present in the splitter box is removed by the clarifiers, and the WTP is capable of meeting the secondary MCL for iron.

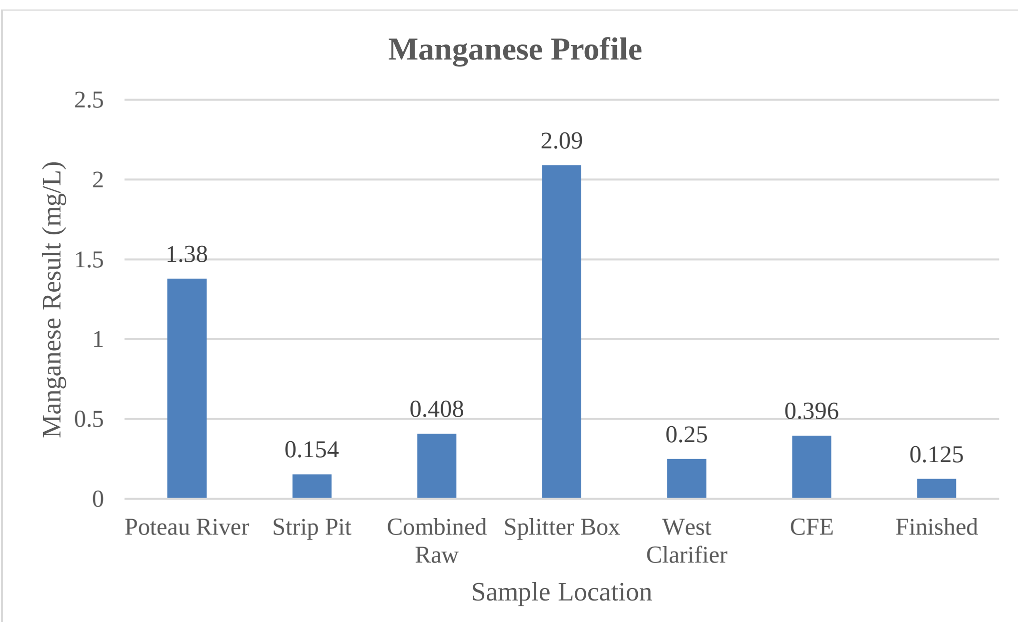

Figure 5: Manganese samples from Heavener WTP major unit processes on August 28, 2019

According to results, the WTP removed 69.3 percent of manganese present in the combined raw water. The finished water manganese concentration was 0.125 mg/L, which is two and a half times higher than the secondary MCL for manganese. The concentration of manganese from the Poteau River water was approximately 9 times higher than the concentration from the strip pit. Although the WTP was able to achieve some removal of manganese, the sample results indicate that the WTP was not able to meet the secondary MCL for manganese that day. Therefore, it appears that manganese is causing aesthetic effects in the distribution.

Parameters such as time and pH can change the amount of manganese removed by oxidation. Currently, the Authority injects potassium permanganate in the aeration basin to oxidize manganese, so it can be removed by sedimentation and filtration. Sufficient contact time must be provided to allow all of the potassium permanganate to react with manganese. Moving the potassium permanganate injection point upstream would increase the contact time and may improve manganese removal. The industry standard for this process is to add 1.9 grams of potassium permanganate for each gram of manganese removed. This proportion can vary depending on pH, as a higher pH may enable the potassium permanganate to be more effective. Figure 6 shows the results from the pH samples taken during the assessment.

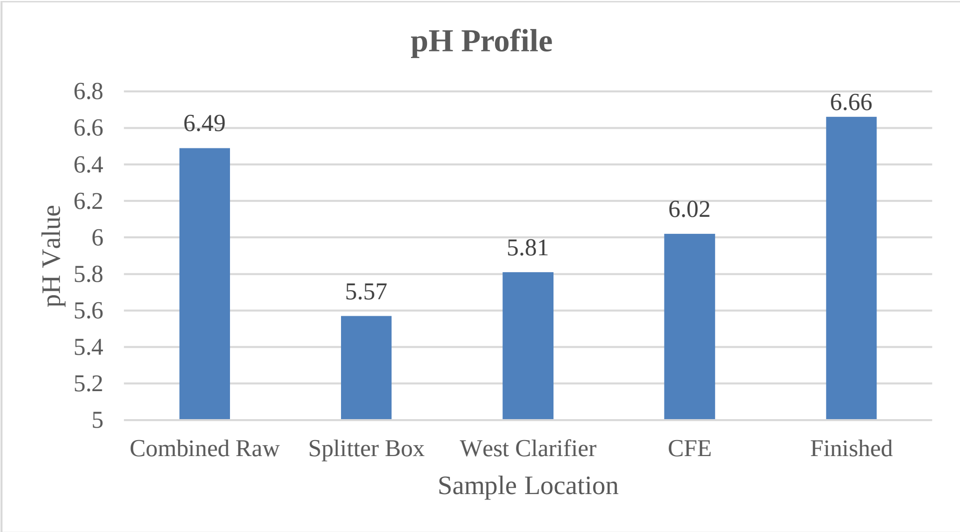

Figure 6: pH samples from Heavener WTP major unit processes on August 28, 2019

After the two raw water sources combine and enter the aeration basin, the Authority adds potassium permanganate for manganese oxidation near the basin inlet and ferric chloride to lower pH for organics removal near the outlet. The pH is later increased with caustic soda before it enters the clearwell. A further study would need to be performed to determine the extent that the change in pH is affecting the potassium permanganate's ability to oxidize manganese. Typically, the oxidation capabilities of potassium permanganate tend to increase at a higher pH. If it is determined that potassium permanganate is not effective given the normal operating pH value in the WTP, the Authority should reassess its treatment strategy for manganese removal.

Like iron and manganese, EPA has not set primary drinking water standards for pH. The secondary MCL for pH is a range of 6.5-8.5. The pH of the finished water sample taken during the assessment was measured to be 6.66, which meets the secondary MCL for pH. At a low pH, a bitter, metallic taste can be noticeable in water, and the water can leach metals from plumbing fixtures. The Authority does add an orthophosphate as a corrosion inhibitor. At a high pH, the water can have a slippery feeling and be difficult to disinfect. It is recommended that the Authority ensure the finished water pH is within the range of 6.5-8.5, effective for treatment processes, and noncorrosive.

Capacity

Purpose – Assess the major unit process capacities to ensure the WTP can meet water demands.

Description – The treatment capacity of four (4) major unit processes was assessed based on the State of Oklahoma Public Water Supply (PWS) Construction Standards and the Surface Water Treatment Rule (SWTR) disinfection requirements. These unit process capacities were then compared with the peak operating flow rate based on a historical review of MORs from June 2018 to May 2019.

Findings – In Figure 7, unit processes are named on the left side of the graph. Horizontal bars on the graph represent the capacity in gallons per minute (gpm) of each unit process. For the flocculation and sedimentation unit processes, the light blue bar indicates the capacity of the East Clarifier. The dark blue bar indicates the capacity of the West Clarifier. For the filters, the light blue bar indicates the total capacity with all six filters in service; the dark blue bar indicates the regulatory capacity (largest unit out of service) of the filters, only five filters in service. For the disinfection process, the light blue bar indicates the capacity to inactivate *Giardia* and viruses given a worst-case scenario.

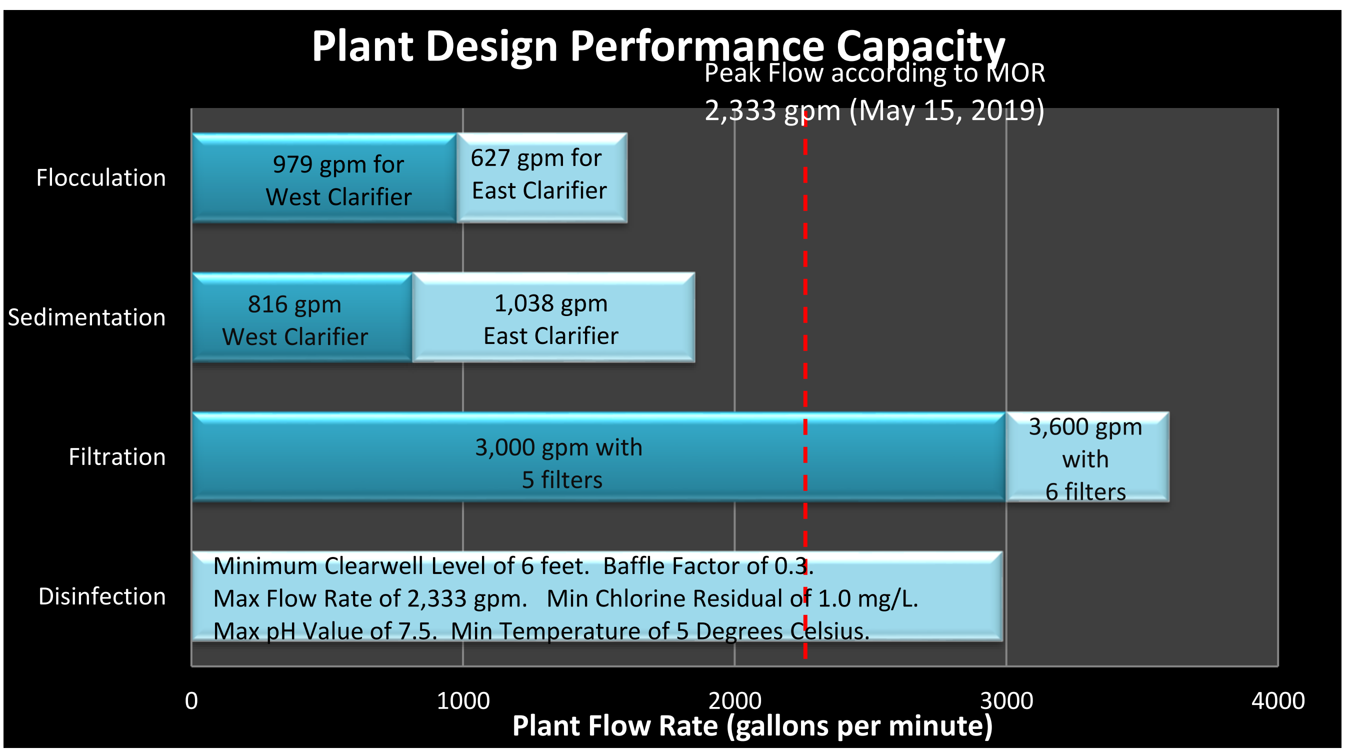

Figure 7: The calculated capacities of each major unit process

Determination of Maximum Daily Flow Rate

The maximum daily flow rate was determined to be 2,333 gpm or 3.36 MGD, and the average daily flow rate was determined to be 2.05 MGD based on a review of plant records for June 2018 through May 2019.

Flocculation/Sedimentation Basins

The capacity of both clarifiers operating simultaneously was rated at 1,606 gpm or 2.31 MGD for flocculation and at 1,854 gpm or 2.67 MGD for sedimentation with regards to state construction standards. The flocculation and sedimentation rate was based on the following:

Number of clarifiers	2
Dimensions of the East Flocculation Zone	10 ft radius, water depth of 8 ft
Dimensions of the East Sedimentation Zone	25 ft radius, water depth of 14 ft
Dimensions of the West Flocculation Zone	12.5 ft radius, water depth of 8 ft
Dimensions of the West Sedimentation Zone	25 ft radius, water depth of 12 ft
Minimum detention time - flocculation	30 minutes
Minimum detention time - sedimentation	3 hours

The capacities are based on field measurements and dimensions provided by the Authority and plant operators. According to plant operators, the capacity of both clarifiers operating simultaneously was rated at 3.0 MGD after their construction. A capacity of 3.0 MGD still does not meet the demand from the maximum daily flow rate.

Filters

The filtration capacity was determined in accordance with the state construction standards that requires the capacity to be based on operation with the largest filter out of service. The filtration capacity was also determined with all six filters in service. Considering only five filters in service, with one filter out of service, the capacity of the filters was rated at 3,000 gpm or 4.32 MGD and considering all six filters in service, the capacity of the filters was rated at 3,600 gpm or 5.18 MGD. This was based on the following:

Number of filters	5 (out of a total of 6 filters)
Dimensions for each filter	10 ft x 15 ft each
Filter loading rate (for multimedia)	4 gpm/ft^2

Filter capacity, even with one filter out of service, is adequate to meet the maximum daily flow rate.

Disinfection Process

Assessment of the capacity of the disinfection process was based on the Surface Water Treatment Rule (SWTR), which requires at least a 3-log removal/inactivation of *Giardia Lamblia* and 4-log for viruses, by a surface water treatment plant. At the Authority's water treatment plant, the flocculation basins, sedimentation basins, and filtration processes taken together received credit for 2.5-log removal of *Giardia*. The remaining 0.5-log credit must be achieved by disinfection. To achieve this inactivation, chlorine gas is injected after the filters, but before the clearwell. The capacity of the disinfection process was calculated using the values below.

Capacity of the clearwell	795,300 gallons
Minimum operating water depth	6 ft
Baffling factor	0.3
Chlorine residual (minimum value)	1.0 ppm
pH, maximum	7.5
Water temperature, minimum	5°C

The disinfection process is adequate to meet the maximum daily flow rate. However, these calculations must be updated as parameters change.

Filter Study

Purpose – To determine filter media depth or condition that may be affecting finished water quality and if the media is adequately expanding during a filter backwash.

Description – Measurements are taken to assess the media depth at representative points across the media surface using a probe. Then, a small portion of the filter is evaluated to determine if any mud balls are present and if different types of media are separate at the proper depth. To assess the effectiveness of the filter backwash process, the expansion in media depth during backwash is measured using a bed expansion-measuring device. Then, the percentage of media expansion is calculated based on height of the bed before and during expansion.

Findings – Due to Veolia's confined space policy, DEQ personnel were unable to measure the filter media depths. The Authority expressed interest in contracting a licensed third party to perform the assessment at a later date. The bed expansion of the filter bed could not be confirmed due to the backwash being initiated in Filter 6 when the bed expansion measuring-device was set up in Filter 4. Based on visual observations, the backwash of Filter 6 was inadequate to clean the filter bed, and the backwash cycle was unable to be completed because the residuals lagoon was full. Currently, one of the two lagoons is inoperable because of vegetation overgrowth and lack of proper maintenance. The operable lagoon does not have the capacity to handle routine backwashes of the filters. It is essential to filter performance that regular and adequate backwashes be performed.

Turbidimeter Verification

Purpose – To assess the accuracy of the turbidimeters.

Description – Compare the turbidity reading of a grab sample measured using the calibrated DEQ Hach 2100P handheld turbidimeter to the result shown on the individual filter effluent online turbidimeters and combined filter effluent online turbidimeter. Measure the flow through the online turbidimeters and compare with manufacturer's recommendations.

Findings - A turbidimeter verification study was conducted at the Authority's water treatment plant on August 28, 2019, and summarized in Table 1 below. There are continuous on-line individual filter effluent turbidimeters for each filter. Samples of water from the individual filter effluent (IFE) turbidimeters were captured and placed into sample cells. The readings from the calibrated DEQ Hach handheld turbidimeter were compared with the reading from the plant's on-line turbidimeters.

Table 1: Comparative results between the Authority's online turbidimeters and DEQ's portable handheld turbidimeter

Location	Turbidimeter Make, Model, Type	Reading From System Turbidimeter Being Evaluated	Reading From DEQ 2100P Turbidimeter (NTU)	Within ± 0.04 NTU, For Readings ≤ 1.0 NTU Yes/No
Filter 1	Continuous Hach TU5300	0.154	0.21	No
Filter 2	Continuous Hach 1720E	0.106	0.28	No
Filter 3	Continuous Hach 1720E	0.089	0.42	No
Filter 4	Continuous Hach 1720E	0.048	0.20	No
Filter 5	Continuous Hach 1720E	0.067	0.28	No
Filter 6	Continuous Hach 1720E	0.077	0.44	No
CFE	Continuous Hach 1720E	0.087	0.21	No

The difference in readings between the units was above the recommended allowable variation of 0.04 NTU. However, it is important to note that the effluent lines from the turbidimeters were covered in sediment, likely increasing turbidity at the sample location. Regularly scheduled maintenance to replace these lines should be implemented and the comparison should be re-evaluated.

In addition, the WTP had continuous Hach TU5300 turbidimeters for the East and West clarifiers. However, these turbidimeters were not operable. While continuous turbidimeters are not required directly following sedimentation, having this data can be useful in making process control decisions to improve water quality.

The recommended flow through the Hach 1720E is 250-750 milliliters per minute (mL/min.) The flow rates through the continuous turbidimeters for Filter 2, Filter 3, Filter 4, Filter 5 and the CFE were not within the recommended flow rate range. None of the turbidimeter effluent lines had air gaps, creating a cross connection. In addition, there were no calibration records.

Chlorine Residuals

During the interview portion of the assessment, concern that a portion of the Authority's distribution system did not have an adequate free chlorine residual was identified. A free chlorine residual protects the finished water from microbial contamination as it travels through the distribution system. An important consideration for maintaining an adequate free chlorine residual is monitoring the chlorine demand. The chlorine demand is defined as the difference between the amount of chlorine applied and the chlorine residual. If the chlorine demand increases, more chlorine will need to be applied to maintain the same chlorine residual. The chlorine demand can increase with temperature, pH, time, and the amount of impurities in the water. Water impurities can include organic matter, sediment, manganese, and other substances.

On September 3, 2019, investigative chlorine samples were taken by DEQ at five locations to verify if the minimum chlorine residual requirement was being met. According to State of Oklahoma PWS Operation Standards, the Authority must maintain a minimum free chlorine residual of at least 0.2 mg/L throughout the distribution system. The free chlorine residual was above 0.2 mg/L at each of the five sample locations. The lowest measured free chlorine residual was 0.42 mg/L. While investigating a complaint on September 10, 2019, DEQ found inadequate chlorine in the Authority's distribution system. The work following up with this complaint is still ongoing.

DISTRIBUTION SYSTEM INTEGRITY

Although the assessment primarily focused on WTP operations for turbidity and manganese removal, a major consideration for the quality of water reaching customers is the integrity of the distribution system. The goal for the distribution system is to maintain water quality as it travels from the WTP to the customer's tap. Main line breaks and the accumulation of manganese can negatively affect the finished water quality. During a main line break, pressure can be lost in the pipes and outside sediment can be pulled into the distribution system causing discolored water. Dissolved manganese can pass through the WTP undetectected by the turbidimeters only to precipitate out of solution in the distribution system causing blackish colored water.

On July 13, 2018, and August 6, 2019, the Capacity Development Coordinator for DEQ performed water loss audits of the Authority's distribution system. When analyzing the Authority's water losses, the distribution system must be separated into two units. One unit supplies OK Foods and accounts for 90 percent of the water supplied; the other unit supplies the rest of the customers and accounts for 10 percent of the total water supplied. Since a single connection accounts for 90 percent of the Authority's water demand, measuring water loss by subtracting the water supplied from the water produced might not accurately represent the overall state of the Authority's distribution system.

According to the water loss audits, the Authority's real water losses per connection per day were the highest of any audited water system in the State. Most of these losses are occurring in the distribution unit that supplies most of the Authority's customers. This shows the Authority has a significant problem with water leaks and possibly the overall integrity of its distribution system. The frequency of waterline breaks are another indicator of the state of the distribution system. In 2019, three major line breaks caused DEQ to recommend a precautionary boil order to protect customers from potentially contaminated water. It is essential a program be implemented to detect and repair waterline leaks and replace deteriorated waterlines.

PERFORMANCE LIMITING FACTORS

Performance limiting factors in the categories of administration, design, operation, and maintenance were identified. Performance limiting factors were based on information obtained from the plant tour, interviews, performance and design assessments, and special studies. Each factor was classified as level A, B, or C factors according to the following guidelines:

- **A-** Major effect on a long term repetitive basis
- **B-** Minimal effect on a routine basis or major effect on a periodic basis
- **C-** Minor effect

Under the limited scope of the technical assistance visit, over fifty (50) performance factors were evaluated. Sixteen (16) were identified as influencing plant performance. There were nine (9) level "A" factors, five (5) level "B" factors, and two (2) level "C" factors identified. The factors were then ranked within each level and weighed in magnitude of their adverse impact on plant performance, with the first one considered as having the greatest impact.

Administration

1. *Policies* – **A**
   - Lack of communication between plant operators and Authority officials contributes to maintenance deficiencies.
   - It was unclear among operators who was responsible for low chlorine residuals in the distribution system. This stems from the fact Veolia employees are only responsible for WTP operations while Authority employees handle distribution system maintenance. There was not a communication system in place for these two groups to provide feedback to each other.

2. *Plant Coverage* – **A**
   - Currently, the WTP is only staffed for eight hours a day; however, the WTP can treat water when operators are not on site. Since the WTP is manually controlled, there would be a delayed response to turbidity spikes or chlorine feed failures when operators are not present at the WTP. Operators were also unsure of the parameters triggering various alarms at the WTP.

3. *Personnel Turnover* - **B**
   - There has been a high turnover rate among the operators.

Design

4. *Filtration* - **A**
   - The backwash of Filter 6 was inadequate. The backwash cycle was unable to be completed because the operable lagoon was full.
   - Bed expansion during the backwash could not be confirmed.
   - The current filter media depths were unknown. Routine evaluations of the filter media should be completed to help assess performance.
   - The plant did not utilize its filter-to-waste capability.
   - The headloss monitoring device was inoperable.

- The lack of flow control through the plant can cause hydraulic surging in the operating filters during backwashes.

5. *Sludge/Backwash Water Treatment and Disposal* **- A**
   - Only one of the two lagoons is operable. The capacity of the operable lagoon is inadequate for necessary backwashes.

6. *Process Instrumentation/Automation* - **A**
   - The turbidity sample taps were located on the top of the pipes and were not drawing a representative sample from the pipe.
   - The length of the tubing from the pipe to the turbidimeter was excessive.
   - The settled water turbidimeters were not functioning properly.
   - The turbidimeter effluent lines did not have an adequate air gap.

7. *Chemical Storage and Feed Facilities* - **A**
   - Most chemicals did not have measuring devices for the feed rate.
   - Several chemicals had excessive feed lines. The chemical storage in the filter gallery did not have adequate spill containment.

8. *Flocculation and Sedimentation* – **B**
   - The clarifiers have the capacity to meet average daily demands but not the maximum day demand.

9. *Flow Measurement* - **B**
   - There were not flow meters for each raw water source.
   - The flow entering each clarifier cannot be measured.

10. *Process Flexibility* - **B**
    - The potassium permanganate did not appear to have enough contact time to react with the raw water.

11. *Sample Taps* - **B**
    - There was not an individual raw water sample tap for each source.
    - There was not a sample tap for the filter-to-waste line.

12. *Alternate Power Source* - **C**
    - There was no backup power available for the WTP.

Operation

13. *Process Control Testing* - **A**
    - From October 2018 to the date of the assessment, MOR turbidity values were being rounded to the tenth decimal point. It could not be verified whether the MOR values matched the SCADA results.
    - The MOR spreadsheet appeared to be capped at a turbidity of 0.3 NTU.

- The SCADA system did not provide the capability to view historical data. Therefore, it is unknown if IFE data is meeting monitoring requirements or triggering additional assessments. Not having this data hinders the operator's understanding of individual filter performance. The Long Term 1 Enhanced Surface Water Treatment Rule requires water systems to maintain the results of IFE turbidity for at least three years.
- It could not be determined if turbidity spikes following filter backwashes were being monitored consistently.
- Log inactivation of *Giardia* and viruses was not being calculated.
- Settled water turbidity samples from each clarifier were not routinely taken.
- The chemical feed equation for the orthophosphate was used for calculating the potassium permanganate feed rate.

14. *Application of Concepts and Testing to Process Control* – **A**
    - Chemical adjustments were not always based on current water quality data. Many of the chemical adjustment decisions were based on qualitative data or a historical hardness concentration from the strip pit.
    - Clarifier performance was measured solely by visual observation rather than process control testing.
    - The filter backwash procedure was inconsistent between operators.
    - Plant filters are placed back in service following backwash without consideration for effluent turbidity levels.
    - Filter backwashes were not being triggered based on optimized turbidity goals.
    - The rates of flow through the turbidimeters were not within the accepted range established by their manufacturer.

Maintenance

15. *Preventative Maintenance* - **A**
    - The current maintenance style is reactive rather than preventative.
    - It could not be verified that any of the turbidimeters had been calibrated within their last service date. There were not any records of the last calibration date.
    - The vegetation in the second lagoon was overgrown and prevented it from being usable.

16. *Corrective Maintenance* – **C**
    - The turbidmeter lines were covered in dirt, possibly skewing the results of the turbidimeter verifications with DEQ's handheld turbidimeter.
    - The online pH meter was inoperable. Continuously monitoring raw water pH data would assist in making treatment decisions.

EVALUATION FOLLOW-UP

The performance limiting factors identified during the technical assistance assessment need to be addressed in a systematic manner. This could be done by focusing on rehabilitating the second residual lagoon, assessing the filter media depths and backwash capacities, and calibrating turbidity-monitoring equipment. Additional modifications to the WTP involving capital improvements may be required to achieve the optimized performance goals on a consistent basis. If you or your staff have any questions, comments, or concerns regarding the findings of the assessment, you may contact Trey Peterson, E.I., District Representative, Public Water Supply Engineering and Enforcement Section, at the letterhead address.