CORRECTIVE ACTION PLAN

APRIL 7, 2017

FLIPPIN

WASTEWATER TREATEMENT PLANT IMPROVEMENTS

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Introduction

The City of Flippin, Arkansas received a request from the Arkansas Department of Environmental Quality (ADEQ) for a submission of a Corrective Action Plan (CAP) for the Flippin Wastewater Treatment Plant (WWTP), NPDES Permit # AR0021717. The request, dated February 21, 2017 outlines twelve (12) permit violations in the year 2016. The permit violations are summarized in the table below.

Date	Parameter	Sample Value	Permit Limit
4/30/16	NH_4^+ (MO AVG)	19.69	5.7
4/30/16	NH_4^+ (MO AVG)	11.83	3.9
4/30/16	NH_4^+ (7 DAY AVG)	14.8	3.9
5/31/16	TSS (MO AVG)	22	21.9
5/31/16	NH_4^+ (MO AVG)	10.4	2
5/31/16	NH_4^+ (7 DAY AVG)	10.4	3
6/30/16	NH_4^+ (MO AVG)	9.4	2
6/30/16	NH_4^+ (7 DAY AVG)	9.4	3
8/31/16	NH_4^+ (MO AVG)	7.4	2
8/31/16	NH_4^+ (7 DAY AVG)	7.4	3
9/30/16	NH_4^+ (MO AVG)	4.7	2
9/30/16	NH_4^+ (7 DAY AVG)	4.7	3

This CAP outlines the planned process required to bring the Flippin WWTP into compliance. The current WWTP staff was pursuing compliance and evaluating infrastructure rehabilitation needs prior to the request for a CAP. The staff in coordination with Arkansas Rural Water applied for funding of a CCTV inspection of the existing collection system and this will be followed with jetting equipment as needed. The City of Flippin has already scheduled smoke testing, which Arkansas Rural Water will begin in April to be completed by July 1, 2017. After completion of the inspection and testing, the City will repair areas of infiltration and inflow (I/I) as their operating budget allows. Customers will be notified of any problems with service lines and given 30 days to make those repairs. These actions should help to reduce the I/I and mitigate the associated hydraulic problems within the WWTP.

Existing Infrastructure Audit

Flow Data

The WWTP is only equipped with an effluent flow meter. Influent flows are estimated based upon pump run times at the influent pump station. While metered influent flow is desirable, for the purposes of this report the effluent flow was considered an accurate representation of process flow. The current design flow of the WWTP is 175,000 gallons per day (gpd). The table on the next page summarizes the WWTP flow data in millions of gallons per day (MGD) for the dates of violation.

Date	Flow (MGD)	Average Daily Flow for Month (MGD)	Maximum Daily Flow for Month (MGD)
4/30/16	0.686	0.264	0.707
4/30/16			
4/30/16			
5/31/16	0.453	0.506	0.795
5/31/16			
5/31/16			
6/30/16	0.166	0.244	0.403
6/30/16			
8/31/16	0.303	0.420	0.770
8/31/16			
9/30/16	0.171	0.216	0.285
9/30/16			

The maximum month flow (the largest monthly average of daily flows) for 2016 occurred in May for the year 2016 and came to 0.506 MGD. The maximum month flow is typically used for the design flow and adjusted upward based upon the expected growth for the planning period. With the current amount of infiltration and inflow the current WWTP design flow should be 0.5 MGD, which is well above the current treatment capacity.

Existing Loads

The Flippin WWTP influent raw wastewater is characterized as typical domestic sewage flow. The assumptions outlined in the table below were used for the calculations in this CAP. Adequate raw wastewater testing will be performed before the detailed design of the plant improvements begin.

Parameter	Assumed Concentration	Assumed Loading at Max. Month Flow
COD	500 mg/L	2,085 lb/day
BOD	250 mg/L	1,043 lb/day
$BOD_{soluble}$	100 mg/L	417 lb/day
$BOD_{particulate}$	150 mg/L	626 lb/day
TSS	250 mg/L	1,043 lb/day
VSS	168 mg/L ($^2/_3$ of TSS)	701 lb/day
NH_4^+	20 mg/L	84 lb/day
TKN	30 mg/L	125 lb/day

Existing WWTP Process

The existing influent pump station feeds the WWTP process beginning with raw water screening and grit classification, followed by a single track oxidation ditch (extended aeration activated sludge), final clarification, intermittent sand filters, UV disinfection, and post aeration via a cascade weir. Solids handling infrastructure includes aerobic digestion and sludge drying beds. Each process step is analyzed below.

Influent Pump Station

The existing influent pump station was constructed with the original WWTP in the early 1980's. The station is wet well/dry well with two (2) 15 hp in-line sewage pumps. The station is operational but is in need of replacement. The firm capacity of the existing pump station is published at 365 gallons per minute (gpm), however, without an influent meter the true current capacity is unknown. 365 gpm or approximately 525,000 gpd should be close to the existing capacity. This firm capacity is inadequate for peak wet weather flows and with both pumps operating in parallel the system may still be forced to rely on line storage within the gravity collection system to attenuate the peak wet weather flows. While the treatment processes themselves are typically designed for the maximum monthly flow at the end of the 20 year design period, influent pump stations must be sized to accommodate the peak flows unless equalization is provided.

Raw Wastewater Screening and Grit Removal

The existing stacked unit incorporates the screen and grit classifier into one unit. The screen lacks mechanical cleaning and is; therefore, a constant maintenance item. The vortex grit removal system is adequate but is dated and part of the same unit as the manually cleaned screen. The Utility obtained a construction permit (AR0021717C) on November 1, 2016 to install an automatic bar screen with manual back-up. The bids received for the project came in over budget and the project was not awarded. The Utility requests that the construction permit be voided. A new construction permit including new headworks facilities and all of the planned WWTP improvements found to be required will be applied for at the appropriate time. The proposed headworks facility will be incorporated with the proposed influent pump station improvements if proven feasible during design.

Oxidation Ditch

The oxidation ditch volume is approximately 193,000 gallons. However, depending on the efficiency of the brush rotors at aeration and mixing, the aerated volume may be significantly lower than that. The table below assumes full aeration throughout the oxidation ditch and shows the calculated parameters key to the activated sludge process at the current design flow and at the 2016 maximum month flow. If we were to target a Solids Retention Time (SRT) of 25 days to return operation as an extended aeration plant for the sludge benefits (reduction in solids production due to endogenous decay and stable conditioned sludge), typical of oxidation ditches, a basin volume of 260,000 gallons would be required at 2,500 MLSS. During the PER phase an alternative SRT of 15 days (the calculated minimum for nitrification at 10°C) will be considered. The potential cost savings will be evaluated against the expected additional costs required for increased solids handling. The RAS/WAS values in the table on the next page are calculated assuming a solids concentration of 0.8% (8,000 mg/L) off the bottom of the secondary clarifier.

MLSS	Parameter	Calculated Value at Design Flow (0.175 MGD)	Calculated Value at Max. Month Flow (0.5 MGD)
2,500	SRT	18 days	6 days
	WAS Flow	3,132 gpd	9,427 gpd
1,500	SRT	11 days	4 days
	WAS Flow	3,071 gpd	8,422 gpd

The plant staff has no effective way to control the amount of RAS and WAS. A telescoping valve is located in the bottom of each clarifier scum box that directs sludge to the RAS/WAS pump station. This is the only control for RAS/WAS pumping. The only means of metering the flow is via pump run times assuming the theoretical pump flow rates. The RAS/WAS system is another weak link in the operational capability of the oxidation ditch.

Secondary Clarification

Two (2) existing secondary clarifier units of 18 ft. diameter follow the oxidation ditch. The units are peripheral feed, center discharge units and were installed with the oxidation ditch during the plant improvements in 1987. Apparently the clarifiers were designed to flow in series since one clarifier weir level is 10" below the other. The operators have tried to run the units in parallel utilizing manual adjustment of a stop log but have been unsuccessful in splitting the flow in this way. The table below summarizes the clarifier parameters at the design flow and at the 2016 maximum month flow. The standard parameters are Surface Overflow Rate (SOR), Weir Overflow Rate (WOR), and Solids Loading Rate (SLR), at an assumed 2,500 mg/L MLSS.

	Parameter	10 State Standards Recommendation	Calculated Value at Design Flow	Calculated Value at Max. Month Flow
Series	SOR	<1,000 gpd/sf	689 gpd/sf	1,969 gpd/sf
	WOR	<20,000 gpd/lf	7,000 gpd/lf	20,000 gpd/lf
	SLR	<35 lb/day/sf	18.5 lb/day/sf	45.1 lb/day/sf
Parallel	SOR	<1,000 gpd/sf	345 gpd/sf	984 gpd/sf
	WOR	<20,000 gpd/lf	3,500 gpd/lf	10,000 gpd/lf
	SLR	<35 lb/day/sf	9.3 lb/day/sf	22.6 lb/day/sf

The SLR in the table is based upon a theoretical MLSS of the aeration basin of 2,500 mg/L. Given the lack of operator control over wasting it is likely that the MLSS is higher at times and; therefore, the clarifier SLR may be much higher. Another reason why wasting may be inadequate is due to the inadequacy of the solids treatment train. At times, solids must be built-up within the oxidation ditch/clarifier system simply because the operator has nowhere to waste them. The solids treatment system is discussed further below. The clarifiers are undersized for the maximum month flow and significantly undersized for the maximum daily flow, especially when run in series. Solids are often washed over into the intermittent sand filters such that it might be the primary method of wasting sludge.

Intermittent Sand Filters

Following clarification the wastewater is directed into a dosing tank for Intermittent Sand Filter (ISF) dosing. The ISFs were added during the 1987 WWTP improvements. The filter media is 20 years old and is in need of replacement. The beds are dosed via a center fed pipe riser, and this does a poor job of evenly distributing flow over the entire bed. The area near the center feed is over-dosed while the periphery is under-dosed. This type of dosing system could not be considered intermittent because it takes an extended period for the flooded beds to dissipate. As discussed above, due to the inadequacies of the existing clarifiers, a large amount of solids are washed over onto the intermittent sand filters. While the ISFs are efficient at TSS removal, this method of solids handling is not efficient and the ISFs require constant operator attention to remove the solids build up.

U.V. Disinfection

The Ultra-violet disinfection facility is in good working order. It was constructed in the 1987 improvements and was upgraded in 2011. The 2011 upgrades allow for flows up to 0.7 MGD, and the channel will allow for additional bulb arrays in the future. This facility should need no improvements.

Post Aeration

A 5-step cascade weir is utilized for post aeration. The Nov. to Apr. instantaneous limit of 9.2 mg/L is only 0.9 mg/L below the saturation concentration at 15°C, which is a very likely water temperature to occur in November, March, and April. The facility often has to over-aerate in the oxidation ditch in order to carry over enough D.O. to meet the permit limit. The permit justification section references APCEC Regulation 2.505. The water quality standard shown there is 6.5 mg/L D.O. minimum.

Existing Solids Handling Infrastructure

The existing solids handling treatment train consists of an aerobic digester followed by sludge drying beds. The volume of the digester is approximately 88,000 gallons which allows for an approximate 21 day residence time at the design flow, assuming a total sludge yield of 1 dry ton per million gallons flow. This residence time is inadequate for acceptable volatile solids and pathogen reduction, necessitating landfill disposal. There are four (4) sludge drying beds with a total surface area of 2,265 sf. These beds are severely overloaded based upon the typical 20 lb/sf/year design value. A considerable amount of improvement is needed in the solids handling train of the WWTP. The lack of solids handling capability affects the ability to adequately waste solids and; therefore, also impacts the clarifier and oxidation ditch operations.

Causes of the Reported Violations

The reported 2016 violations are expected to primarily be a result of solids washout. High flows and inefficient clarification result in a loss of the nitrifying biomass which requires much longer residence time than the biomass responsible for BOD reduction. The treatment units are undersized and should be expanded. Another contributing factor may also be inefficient

aeration within the oxidation ditch. The ISFs have been effective at allowing the plant to meet the CBOD and TSS limits (however; very short SRTs are effective at BOD and TSS removal) but are not effective in preventing a pass-through of the soluble ammonia. ISFs can be an effective nitrifying treatment step but must be dosed intermittently and allowed to reaerate between doses. The aged filter media and inefficient dosing system are not conducive for the ISFs to act as a nitrifying treatment step.

With an effective oxidation ditch and clarification system the permit parameters should be achievable without ISFs, although polishing filters may be needed to ensure consistent permit compliance.

Proposed Action Plan

The preceding analysis has proven the inadequacy of some of the existing treatment units. Additional aeration volume, larger secondary clarifiers, and an expanded solids treatment train may be required to consistently meet the permit limits. Collection Systems improvements will also be evaluated to determine the cost of reducing I/I and wet weather flows. These improvements will be considered and analyzed for design development within a Preliminary Engineering Report (PER). The PER will serve as the initial design and cost estimating phase of the proposed improvements. A PER is required of USDA, ANRC, and other funding agencies. A proposed time to completion schedule of the process from the PER stage to estimated project commissioning is shown on the next page. While there could be some overlap between some of the steps, the schedule is intended to be read such that each step is completed before the consecutive step begins.

Action	Estimated Days to Completion Once Begun
RFQ Engineer Selection Process	30
Draft Preliminary Engineering Report	150
Final Preliminary Engineering Report	90
Flippin Sewer Rate Increase	90
90% Construction Documents Review	180
Final Construction Documents	90
Bidding	60
Begin Construction	60
Substantial Completion/Start-up	600
Full Compliance with Permit Limit	90
Total Consecutive Days to Permit Compliance	**1,440**

The City of Flippin has been working toward more immediate actions to facilitate plant operations and permit compliance. In addition to the I/I study, smoke testing, and CCTV inspection previously discussed in the ***Introduction***, the City is in the process of purchasing some additional testing equipment for the WWTP. They recently completed the purchase of a Hach HQDPH DO meter. They are currently looking to acquire ammonia and alkalinity testing

capabilities. The City has also been in discussion with the neighboring City of Mountain Home, AR about assistance with some WWTP testing (determining MLSS) to help with operational process control.

Conclusion

The Flippin WWTP staff and City officials understand that significant improvements are needed at the WWTP as well as within the collection system in order to reduce wet weather flows. The temporal nature of such construction projects is always longer than desired but it is required that all things be sufficiently evaluated to ensure a successful project. The schedule outline above gives estimated days for the project progress milestones, to which the City of Flippin and CWB Engineers, Inc. are devoted to meeting and, where possible, exceeding. ADEQ will be updated as the project progresses with appraisals of actions to date and projection of any potential changes to the estimated days required. The ADEQ requested date of full compliance by December 31, 2017 is not feasible given the current condition of the WWTP infrastructure and the amount of work required to ensure full compliance.