CORRECTIVE ACTION PLAN

WASTEWATER TREATMENT PLANT
PERMIT AR0036692
MENA WATER UTILITIES

STATE OF ARKANSAS
REGISTERED PROFESSIONAL ENGINEER
No. 11386
CRAIG L. BECKHAM

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CLB Engineers, Inc.
923 Hickory Street
Texarkana, Arkansas 71854
903-278-2381

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1.0 EXECUTIVE SUMMARY

The existing Wastewater Treatment Plant was originally constructed in 1970 and consisted of a triplex Influent Pump Station, two Lagoons operating in series and a chlorination system. As permit requirements became more stringent, tertiary treatment was provided in 1986 by the addition of four sand filter units, a baffled chlorine contact chamber and post aeration. Then in 1996 fine bubble diffusion was installed in both Lagoons to aid in the biological treatment within the two facultative Lagoons. As solids accumulation became more evident within Lagoon #1, an Influent Bar Screen was installed in 2009 to remove the larger visible solids prior to the Influent Pump Station and Lagoon #1. With the most recent Permit renewal, dechlorination was required and a plan is currently pending approval. The current Wastewater Treatment Plant with all treatment units as noted has been designed with a Design Flow of 3.10 MGD max day flow and 0.775 MGD average day flow. The two Lagoons consist of a combined 55 acres at a depth of six feet with a combined detention time of 34 days and 138 days for max day and average day flows respectively.

Under influent flow conditions at or below the max day flow of 3.10 MGD, the Plant has historically proven to be capable of operating in compliance with permit limits. However, the following areas of concern is a detriment to the future successful operation of the existing Plant.

- **Inflow & Infiltration** has increased over the years to the point that the existing Plant is not capable of storing the excess influent flow and properly treating the flow stream ultimately resulting in the need to by-pass. A Sanitary Sewer Evaluation and Survey of the existing collection system is required to identify and correct all areas of known inflow and infiltration. This effort will help to maintain the influent flow to the Plant within the max day design flow of 3.10 MGD and thereby eliminate the need to bypass.

- **Sludge Accumulation** to depths of five feet at places within the Lagoons has greatly diminished the storage capacity and treatment capability of the Lagoons. In addition to reduction of hydraulic storage capacity, the presence of sludge accumulation can also cause Ammonia Nitrogen levels to exceed permit limits. Sludge removal is required to regain full hydraulic capacity and reduce the seasonal increase of Ammonia Nitrogen levels. Also, the continuous alum laden waste stream from the Sand Filters are directed back to Lagoon #1, which has proven to be a major contributor of inert sludge accumulation within Lagoon #1. This waste stream could be directed to a segmented section of Lagoon #1 and allowed to settle in the confined cell for annual removal or a mechanical sludge filtration system (sludge box) could be installed for continuous dewatering and disposal.

- **Algae Bloom** in Lagoon #2 is a routine occurrence within the warmer months of the year and cause spikes in the total suspended solids. Such events causes a significant decrease in the filtration rate of the Sand Filters thereby rendering the Plant unable to treat to the max day flow of 3.10 MGD. One proven method to prevent Algae Bloom is the installation of floating covers over a specified area of the effluent end of Lagoon #2.

- The existing **Sand Filters** have been in continuous operation for 32 years, which is two year beyond their stated design life. Areas of corrosion has been continuously repaired during this time about their exterior, but a full evaluation of their interior is necessary to determine their anticipated remaining life. In addition to the concern of their structural integrity, the influent of the filters is injected with the coagulant, alum as a filtration aid. This coagulant within the filtration process produces a continuous alum laden waste stream from the Filters that is directed back to Lagoon #1. This waste stream can be corrected as noted in the Sludge Accumulation section above.

- The north **Levee** of Lagoon #2 has exhibited evidence of seepage along the levee's back slope for several years. For continued use of Lagoon #2, a Levee Analysis must be prepared to determine the Levee's current condition and possible corrective action(s).

- Until the inflow and infiltration within the collection system is reduced and the sludge is removed to provide full hydraulic storage capacity, the existing **By-Pass** needs to be repaired to be fully operational to allow by-passing in events of high flows.

Each of the areas of concern noted has the potential of becoming a major contributor to non-compliance alone, or most likely in conjuction with the other concerns and must be addressed for continued successful operation of the existing Wastewater Treatment Plant.

2.0 EXISTING FACILITIES

2.1 PERMIT REQUIREMENTS

Effluent requirements are set in Permit AR0036692.

2.2 FLOW

The Permit does not specify a flow; instead, it simply requires daily reporting for subsequent determination of Monthly Average Flow and Monthly Max flows.

However, the design flow of the existing wastewater treatment plant (WWTP) is 3.10 MGD. The influent gravity line conveying all wastewater to the WWTP is a 36-inch RCP with a capacity of 5.88 MGD.

From historical data, the dry weather influent flow to the Plant is in the range of 0.60 MGD to 0.80 MGD. However, during moderate rain events the influent flow routinely will peak and remain at the maximum Influent Pump Station capacity of 4.32 MGD for several days.

See the Case History from records maintained during a rain event in early 2018.

Rainfall and flow data was collected February 17, 2018 through March 15, 2018, a period of 27 days.

Rainfall totaling 19-inches was measured from February 17 to February 28. The rain event resulted in two different sources of increased flow to the Plant; increased flow consisting of rainfall onto the combined 55-acre lagoons and increased flow from inflow and infiltration within the collection system.

First, rainfall that fell onto the surface of the lagoons contributed 28.37 MG, or an average of 1.05 MGD. And with a Plant design flow of 3.10 MGD, the collected rainfall required just over 9 days to treat and pass through the plant.

Second, the influent received at the Plant during the 27 day period was 98.7 MG, or an average of 3.65 MGD. This amount of flow would take approximately 32 days to treat and pass through the plant at the design flow of 3.1 MGD. The combined flow from rainfall onto the Lagoon surface and the increased influent flow from inflow and infiltration to the Plant contributed a total of 127 MG and would require 41 days to treat and pass through the Plant. However, with the storage capacity of the Lagoons drastically reduced, the same volume of 127 MG being passed through the Plant within the 27-day study period would require a constant Plant effluent of 4.70 MGD. Without the two additional sources of increased flow to the Plant, normal influent flow to the Plant is approximately 0.75 MGD.

The difference between the average flow to the peak rain event flow represents an increase in flow to the Plant of more than 600%, attributed to inflow and infiltration and surface rain onto the Lagoons.

It should be noted that after the rain event ended on February 28, the increased influent to the Plant continued for another 15 days and only decreased by 0.20 MGD until the normal flow of approximately 0.75 MGD was reached. This trend of continued high influent after a rain with a decrease of 0.20 MGD has been witnessed during all significant rain events.

Considering the case history with

- inflow and infiltration contributing 3.65 MGD to Plant,
- rainfall onto the Lagoons' surface contributing 1.5 MGD and
- the Lagoons' storage capacity drastically reduced due to sludge accumulation

the combined influent flow of 4.70 MGD to the Plant cannot be treated and must be bypasses. And the existing bypass in operation is currently in poor condition and not completely reliable.

2.3 INFLUENT BAR SCREEN

To prevent rags and other unwanted items from entering the downstream Influent Pump Station, an Influent Bar Screen was installed in 2009 with a design flow of 3.1 MGD. The Bar

Screen, located just upstream of the Influent Pump Station is a static bar screen equipped with an automatic rake. The rake is controlled by headloss across the screen, thereby preventing any overflows due to a plugged screen within the Screen specified design flow. However, in recent years the incoming flow has exceeded the design flow and overflows have occurred. The Influent Bar Screen is in good operational condition with no concern for failure other than routine maintenance items.

2.4 INFLUENT PUMP STATON

The Influent Pump Station was constructed with the original WWTP in 1970. The Pump Station is a triplex flooded suction type station with a hydraulic capacity of 1,260 gpm at 46 feet of total dynamic head (TDH) with one pump in operation. With two or three pumps in operation the flows are 2,200 gpm and 3,000 gpm respectively. These pumping rates result in the total possible influent into Lagoon #1 and the WWTP as follows.

1 Pump in Operation.................1,260	gpm	=	1.81	MGD WWTP Influent
2 Pumps in Operation................2,200	gpm	=	3.17	MGD WWTP Influent
3 Pumps in Operation................3,000	gpm	=	4.32	MGD WWTP Influent

The Pump Station's wet well has not experienced overflows until recently where the incoming flow has exceeded its total hydraulic capacity with all three pumps in operation. The Influent Pump Station has been well maintained with only impeller and motor replacement with like design. Therefore, the Influent Pump Station is in relatively good operational condition with no immediate concerns of pending failure.

2.5 LAGOON #1

Just down-stream of the Influent Pump Station is existing Lagoon #1, the first in series of the two lagoons with the influent point at its west end. It is a facultative lagoon with a surface area of approximately 25 acres and an operating depth of five feet. The Lagoon is a continuous, flow–through type system with a detention time of 54 days. The Lagoon is equipped with fine bubble diffusion installed in 1996, however the air provided does not satisfy the design parameters of an aerated lagoon nor a partial mix lagoon. Therefore, the aeration is only to assist in maintaining adequate dissolved oxygen to aid in the biological processes due to the Lagoon's shallower than desired depth. The Lagoon has an excessive accumulation of sludge to depths of four feet in some areas with an average of 7% solids throughout the sludge profile, thereby causing a reduction in hydraulic capacity accordingly. To aid in the settling of the sludge, a curtain was installed the full width of the Lagoon located in the eastern portion of the Lagoon. Situated at its extreme northwest corner of Lagoon #1, the outlet piping conveys all flow through a common levee and into Lagoon #2. As stated, Lagoon #1 has an excessive build-up of sludge and the curtain is in poor condition with several tears along its length.

2.6 LAGOON #2

Existing Lagoon #2 is the second in series of the two lagoons receiving its flow stream from Lagoon #1 at its extreme southeast corner. It too is a facultative lagoon with a surface area of approximately 30 acres and an operating depth of five feet. As with Lagoon #1, the Lagoon is a continuous, flow–through type system with an even greater detention time of 65 days. In the same manner, Lagoon #2 is equipped with fine bubble diffusion. As can be expected when in series, Lagoon #2 has a lesser amount of sludge accumulation up to depths of two feet in some areas reducing its hydraulic capacity accordingly. During the hotter season of the year, Lagoon #2 does experience algae blooms near the outfall in the extreme northwest corner the Lagoon. The effluent of Lagoon #2 is conveyed into the Effluent Control Structure at the Lagoon's water-edge and then to the Sand Filters immediately downstream. The earthen levee along the north bank exhibits the presence of excess moisture along the back slope of the levee in approximately six locations indicative of a leak through the levee.

2.7 SAND FILTERS

In 1986 the WWTP was upgraded to provide tertiary treatment beyond the capability of the facultative Lagoons with the addition Sand Filters. The Sand Filters consists of four separate Dynasand filter units as manufactured by Parkson Corporation. Each filter is 12'x16' in the horizontal direction and a sand media bed height of 40 inches. The Sand Filters operate in parallel and receives the Lagoon #2 effluent through the Effluent Control Structure. To aid in treatment, the coagulant aluminum sulfate (alum) is injected into the flow stream at the Effluent Control Structure. Through natural turbulence within the gravity piping between Lagoon #2 and the Sand Filters, alum is adequately dispersed and mixed evenly through the flow stream to serve as a filtration aid within the Sand Filters. Each Filter is equipped with a backwash system that provides continuous backwashing and cleansing of the Filters' sand media. All backwash flow is then directed back to the Influent Pump Station and subsequently back into Lagoon #1. With such a flow pattern, it is obvious that the excessive sludge accumulation within Lagoon #1 is in part due to the continuous flow of alum laden sludge from the continuously backwashing Sand Filters back into Lagoon #1. The alum sludge has been analytically tested and confirmed that the sludge in Lagoon #1 is mostly inert with little biological potential for further processing and digestion.

The Sand Filters are constructed of all welded steel with a manufacturers recommended design life of 30 years. With the Filters' current status of 32 years of continuous operation, two years beyond the recommended design life of 30 years, continued operation of the Sand Filters has become an obvious area of concern. Despite the Filters' outward appearance of relative good structural and operational condition, the condition of the Filter's internal integrity is unknown until such inspection can be performed.

Loading rates of the Filters vary depending in the influent flow the WWTP as follows.

Loading Rate w/ 1 Pump in Operation = 1,260 gpm = 1.81 MGD = 1.64 gpm/sf

Loading Rate w/ 2 Pumps in Operation = 2,200 gpm = 3.17 MGD = 2.87 gpm/sf

Loading Rate w/ 3 Pumps in Operation = 3,000 gpm = 4.32 MGD = 3.91 gpm/sf

2.8 CHLORINE DISINFECTION

Disinfection is by chlorine in the gaseous state with in an existing cast-in-place concrete Chlorine Contact Chamber. The disinfection system consists of a one-ton chlorine gas cylinder housed within a properly designed enclosure, a chlorinator and an injector / diffuser. Original design was such that chlorine was injected in the influent of the Chlorine Contact Chamber which would provide a 16-minute contact time at design flow of 3.10 MGD. The Contact Chamber is 40 feet x 32 feet in size with a constant depth of 4 feet and provided with baffling for a serpentine flow pattern to maximize contact time and disinfection efficiency. However, the chlorine injection point has been relocated to the influent header of the Sand Filter. This modification was made to aid in the reduction of algae, which is prevalent in the Lagoon #2 effluent. As a result, the chlorine contact time consists of the 16 minutes within the exiting Chlorine Contact Chamber as well as an additional eight minutes in the Sand Filters for a total contact time of 24 minutes. The existing Chlorine Disinfection system is presently in good operational condition with no concerns to date. Chlorine dose rate is such that an instantaneous maximum residual of 0.09 mg/l is not exceeded.

2.9 DECHLORINATION

Per requirements of NDPES Permit 0036692 renewal dated July 27, 2017, Dechlorination is required with an instantaneous maximum chlorine residual of 0.011 mg/l. With that, plans have been submitted and tentatively approved for the addition of Dechlorination. Through analytical testing and on-site trials, it has been determined that Sodium Thiosulphate is the most effective dechlorination product at a dose rate of 1.8 mg/l per 1.0 mg/l of chorine residual. Contact time for dechlorination is only 30-seconds, which only represents the last seven feet of flow path within the existing Chlorine Contact Chamber. Therefore, the existing Chlorine Contact Chamber is of sufficient size to accommodate both chlorine contact time for chlorine disinfection and contact time for dechlorination by sodium thiosuphate. The dechlorination system shall consist of a sodium thiosulphate tote, a day tank, a metering pump and an air-inducted injector / diffuser.

2.10 POST AERATION

After sulfonation from the chlorination and dechlorination processes, aeration is required to maintain the desired 2 mg/l dissolved oxygen at discharge. Post aeration is currently provided by cascade aeration through a stainless steel static cascade aeration structure. The exiting cascade aeration system is currently exceeding the permit monthly average of 7.1 mg/l dissolved oxygen and in good structural and operational condition with no concerns for its intended function.

3.0 TREATMENT OVERVIEW

The existing Wastewater Treatment Plant consisting of all treatment units as described in Section 2.0 of this Assessment operates under Permit AR0036692 with a design flow of 3.10

MGD. Four primary parameters monitored for compliance within the Permit is Flow, BOD5, TSS and NH4. From review of the monthly Discharge Monitoring Reports (DMR's), it is obvious that the existing Plant is capable of maintaining compliance as permitted with exception to two events; excessive inflow and infiltration within the collection system and algae blooms within Lagoon #2.

3.1 WASTEWATER CONSTITUENT REMOVAL EFFICIENCY

Because biological nor mechanical treatment efficiency is of concern, analytical data for each treatment unit has not been analyzed for this Assessment. However, on overview of treatment efficiency is provided and based on the measured average effluent levels BOD5 and TSS. Under current and past operations, the average BOD5 and TSS at the Plant discharge is 3 mg/l BOD5 and 10 mg/l TSS.

3.1.A BOD5 REDUCTION

A BOD5 loading at the Plant influent has been assumed to be 250 mg/l, which is a conservative loading.

BOD5 Entering the Lagoons (assumed design).. 250 mg/l

BOD5 Leaving Lagoons #1 & #2 / Entering Filters (assume 88% reduction) .... 30 mg/l

BOD5 Leaving the Filters (<10 mg/l per Filter Manufacturer)............................. 10 mg/l

Within facultative lagoons, BOD5 reductions can be expected to be within the range of 65% to 95% reduction of the influent. The assumption of a combined 88% BOD5 reduction within both Lagoons having a combined detention time of 119 days is conservatively reduction and within the acceptable efficiency range for BOD5 reduction within facultative lagoons. And as specified by the Filter manufacture (Parkson), the Filters are designed to receive a BOD5 loading up to 30 mg/l with an effluent of 10 mg/l. With an average of 3 mg/l BOD5 at the Plant discharge, it is apparent that the treatment units noted and in combination with chlorination are exceeding these assumed and acceptable BOD5 reductions.

Historical data indicates that maintaining compliance for the BOD5 Permit effluent limits of 10 mg/l for the monthly average and 15 mg/l for the 7-day average has never been an issue.

3.1.B TSS REDUCTION

In the same manner, a TSS loading at the Plant influent has been assumed to be 250 mg/l, which also is a conservative loading.

TSS Entering the Lagoons (assumed design) .... 250 mg/l

TSS Leaving Lagoons #1 & #2 / Entering Filters (assume 60% reduction)............ <100 mg/l

BOD5 Leaving the Filters (<10 mg/l per Filter Manufacturer)............................. <10 mg/l

Within facultative lagoons, TSS reductions can be expected to be within the range of 65% to 85% reduction of the influent. The assumption of a combined 60% BOD5 reduction within both Lagoons having a combined detention time of 119 days is a very conservative reduction falling below the typical range. And as specified by the Filter manufacture (Parkson), the Filters are designed to receive a TSS loading of less than 100 mg/l with an effluent of less than 10 mg/l. With an average of 10 mg/l TSS or less at the Plant discharge, it is apparent that the Lagoons and Filters in combination are providing adequate TSS reduction.

Under influent flow conditions that are within the Plant's design flow of 3.10 MGD, meeting the TSS Permit effluent limits of 15 mg/l monthly average and 22 mg/l 7-day average is normally achievable. However, two scenarios do present challenges in meeting Permit effluent limits; rain events and algae blooms in Lagoon #2. Influent flow to the Plant above the design flow caused by inflow and infiltration within the collection system increases the hydraulic loading rate of the Filters to the point they are do not provide adequate treatment. Also, algae blooms in Lagoon #2 near the effluent increases the TSS loading to the Filters to such a level that the Filters are not able to provide adequate treatment at flows below the design flow.

3.1.C AMMONIA NITROGEN REDUCTION

Like BOD5, reduction of Ammonia Nitrogen through nitrification primarily takes place within the Lagoons as a secondary biological process after BOD5 reduction. The main ingredients and factors that allow for proper nitrification include the following.

1. Dissolved oxygen content in the amount of 2 mg/l – 5 mg/l
2. BOD5 removal to a BOD5 level 20 mg/l – 30 mg/l
3. pH in the of 7.5 – 8.0
4. Water temperature of at least 82 degrees
5. Adequate mixing

With differing Permit effluent limits for Ammonia Nitrogen of 4.5 mg/l for the months of April through October and 12.0 mg/l for the months of November through March, it is evident that temperature alone plays a major role in successful nitrification of Ammonia Nitrogen. During the majority of the year, Ammonia Nitrogen at the Plant discharge is well within Permit limits; however, late summer and early fall has proven to be an operational challenge with Permit excursions for the months of October 2017, September 2018 and October 2018.

3.2 OVERALL TREATMENT PLANT EFFICIENCY

With consistent and adequate BOD5 removal and only occasional Permit excursions in TSS and Ammonia Nitrogen, it is apparent that the overall Wastewater Treatment Plant's treatment capability and efficiency is able to satisfy Permit requirements with exception to a few operational scenarios and infrastructure concerns;

- Excessive Inflow & Infiltration causing high influent flow to the Plant which cause Permit violations with TSS,
- Algae blooms in Lagoon #2 causing a decreased hydraulic loading rate to the Filters and
- Excess sludge accumulation causing Ammonia Nitrogen release.

4.0 CORRECTIVE ACTION PLAN

In summary, the primary areas of concern are as follows.

- Excessive Influent Flow to the Plant (Inflow & Infiltration)
- Sludge Accumulation within the Lagoons
- Algae Blooms in Lagoon #2
- Sand Filter Evaluation
- Levee Analysis for possible Seepage Through the North Levee of Lagoon #2
- Wastewater Treatment Plant By-Pass

Corrective action required to address the areas of concern and cause for treatment deficiencies noted herein are addressed below.

4.1 EXCESS INFLOW & INFILTRATION

High flows to the Plant has been deemed the single greatest concern in regard to maintaining Permit compliance within Treatment Plant. Excessive inflow & infiltration within the collection system that contributes to flows above the Plant's design flow can only be addressed after completion of a system-wide Sanitary Sewer Evaluation and Survey (SSES).

CORRECTIVE ACTION PLAN

As a result, an SSES is currently being prepared, which includes

- Smoke Testing,
- Manhole Inspections,
- Flow Monitoring and
- Hydraulic Analysis.

Upon completion of the SSES expected in the Spring of 2019, a comprehensive list of collection system repairs will be provided and prioritized in order of severity and needs with a Plan for correction.

4.2 SLUDGE REMOVAL

After excessive influent flow to the Plant, the accumulation of sludge within the Lagoons is considered next most detrimental concern to the continued successful operation of the existing Plant. This issue has been addressed during a Sludge Removal project in 2015 but not a complete removal of all sludge was performed.

CORRECTIVE ACTION PLAN

A Sludge Management Plan will be required to re-evaluate sludge quantities, best removal practices and associated costs. The Plan will provide a method and schedule for such removal once the extent and financial requirements are determined. Sludge that has been previously removed, staged and dewatered during the Sludge Removal 2015 project shall be removed and disposed off site.

4.3 ALGAE BLOOM MITIGATION

To provide a more consistent and treatable effluent from Lagoon #2 and subsequent influent to the Filters, it is recommended to provide a floating cover system within Lagoon #2. Such a system is provided as a complete treatment unit with treatment guarantees and must be prepared by the unit manufacturer.

CORRECTIVE ACTION PLAN

An analysis and evaluation of algae mitigation treatment processes is required to address options and a recommended method for reduction of algae blooms in Lagoon #2.

4.4 FILTER EVALUATION

With the Filters' continuous operation beyond their design life, their outward appearance appears to be in good operational condition. However, continual abatement of exterior surface rust over the years only lends to the concern that corrosion may be present within the internal components of the Filter.

CORRECTIVE ACTION PLAN

An inspection and evaluation of the Filters' internal components and media shall be performed to determine the remaining useful life of the filters.

4.5 LEVEE ANALYSIS

As stated, the levee along the north side of Lagoon #2 has exhibited possible seepage on the levee's back slope for several years. This condition will require further testing and analysis to confirm that seepage is indeed present and a determination of the extent of the possible leakage with best mitigating methods for correction.

CORRECTIVE ACTION PLAN

An analysis of the existing levee shall be performed to determine the status of possible levee seepage and provide corrective actions as applicable.

4.6 PLANT BYPASS

As noted in Case History, the bypass in not fully functional and not reliable when bypassing is necessary.

CORRECTIVE ACTION PLAN

The Plant influent valve and by-pass valve shall be evaluated with appropriate plans prepared as necessary to address and improve as needed to allow dependable operation of both valves.

5.0 MILESTONE DATES OF CORRECTIVE ACTION PLAN

CORRECTIVE ACTION	COMPLETION
BYPASS	March 31, 2019
SANITARY SEWER EVALUATION & SURVEY (SSES)	March 31, 2019
SLUDGE MANAGEMENT PLAN	March 31, 2019
ALGAE BLOOMS MITIGATION ANALYSIS	March 31, 2019
FILTER EVALUATION	March 31, 2019
LEVEE ANALYSIS	March 31, 2019

Report Prepared By:

Craig L. Beckham, P.E.
CLB Engineers, Inc.
923 Hickory Street
Texarkana, Arkansas 71854