PROGRESS REPORT – JUNE 30, 2016

Required by Corrective Action Plan dated August 17, 2015
City of Sheridan Wastewater Treatment System
NPDES No. AR0034347

1.0 INTRODUCTION

This progress report is being submitted to the Arkansas Department of Environmental Quality (ADEQ) as required by a Corrective Action Plan (CAP) dated August 17, 2015. The CAP addresses effluent violations during recent years at the City of Sheridan (Sheridan) wastewater treatment system. As discussed in the CAP, Sheridan's efforts to improve compliance with the National Pollutant Discharge Elimination System (NPDES) permit limits are focused on decreasing effluent concentrations of ammonia nitrogen during cold weather.

Section 2.2 of the CAP outlines three actions to be taken sequentially:

1) The first action was to collect water quality data from the wastewater treatment system during the winter of 2015-2016. This was completed and is discussed below.
2) The second was to identify and evaluate alternatives for achieving compliance for ammonia nitrogen, and then select a viable alternative to be implemented. This has been completed and is documented in this progress report.
3) The third action is to implement the selected alternative. This action will be initiated according to the schedule presented in this progress report.

2.0 WATER QUALITY DATA COLLECTED DURING WINTER 2015-2016

Measurement s of water temperature, dissolved oxygen (DO), alkalinity, and ammonia nitrogen were collected during December 2015 – March 2016 at three locations: a) the flow the first pond to the second pond, b) the flow from the second pond to the holding pond, and c) in the holding pond near the discharge pipe to Outfall 001. Figure 1 shows the flow path of wastewater through the ponds. The water quality data are summarized in Tables 1 – 4.

Low DO values occurred during February due to a minor upset. The cause of the upset could not be determined. DO values in March showed a full recovery from the upset. No permit limits were exceeded during winter 2015 – 2016.

Winter 2015 – 2016 was not as cold as the previous two winters when effluent ammonia concentrations exceeded permit limits. This is consistent with information in the CAP indicating that exceedances of ammonia permit limits are mostly limited to severe cold winters.

Figure 1. Flow path through wastewater ponds.

Table 1. Water temperature measured in Sheridan wastewater ponds.

Date	Measured temperature (°C) at each sampling location		
	Flow from first pond to second pond	Flow from second pond to holding pond	In holding pond near discharge pipe
12-03-2015	--	--	--
12-28-2015	13.1	12.6	--
1-04-2016	8.9	8.2	--
1-26-2016	9.5	10.4	10.2
2-16-2016	11.6	12.0	--
2-23-2016	13.8	13.9	13.5
2-29-2016	15.1	15.4	16.0
3-21-2016	17.2	18.0	--

Table 2. Dissolved oxygen measured in Sheridan wastewater ponds.

Date	Measured concentration (mg/L) at each sampling location		
	Flow from first pond to second pond	Flow from second pond to holding pond	In holding pond near discharge pipe
12-03-2015	--	--	--
12-28-2015	9.86	10.5	--
1-04-2016	12.1	12.0	--
1-26-2016	13.9	15.2	17.0
2-16-2016	7.86	2.58	--
2-23-2016	1.85	1.86	2.57
2-29-2016	2.01	< 1.00	1.63
3-21-2016	15.2	17.2	15.9*

*Discharge at Outfall 001

Table 3. Alkalinity measured in Sheridan wastewater ponds.

Date	Measured concentration (mg/L) at each sampling location		
	Flow from first pond to second pond	Flow from second pond to holding pond	In holding pond near discharge pipe
12-03-2015	90	66	--
12-28-2015	40	< 5	--
1-04-2016	44	49	--
1-26-2016	40	37	35
2-16-2016	55	60	--
2-23-2016	66	66	57
2-29-2016	72	73	68
3-21-2016	41	39	34*

*Discharge at Outfall 001

Table 4. Ammonia nitrogen measured in Sheridan wastewater ponds.

Date	Measured concentration (mg/L) at each sampling location		
	Flow from first pond to second pond	Flow from second pond to holding pond	In holding pond near discharge pipe
12-03-2015	2.33	2.61	--
12-28-2015	4.55	4.71	--
1-04-2016	2.74	3.30	--
1-26-2016	2.47	1.84	1.42
2-16-2016	5.56	5.59	--
2-23-2016	7.87	6.61	4.35
2-29-2016	9.87	9.49	7.50
3-21-2016	4.86	3.75	1.90*

*Discharge at Outfall 001

3.0 HISTORICAL EFFLUENT DATA

Discharge monitoring report (DMR) data for ammonia nitrogen were downloaded from the Environmental Protection Agency (EPA) web site for January 2000 – April 2016. In Figure 2, these data are plotted by month of the year to show that the highest concentrations occur during January through April when water temperatures in the ponds are low. The long term plot of these data (Figure 3) shows that high ammonia concentrations do not occur every winter. In other words, on a long term basis, exceedances of permit limits for ammonia occur infrequently and almost exclusively during severe cold winters. Based on mean monthly temperatures for January – March of each year (data downloaded from National Climatic Data Center), the winters of 2014 and 2015 were the coldest two winters at Sheridan since 1978.

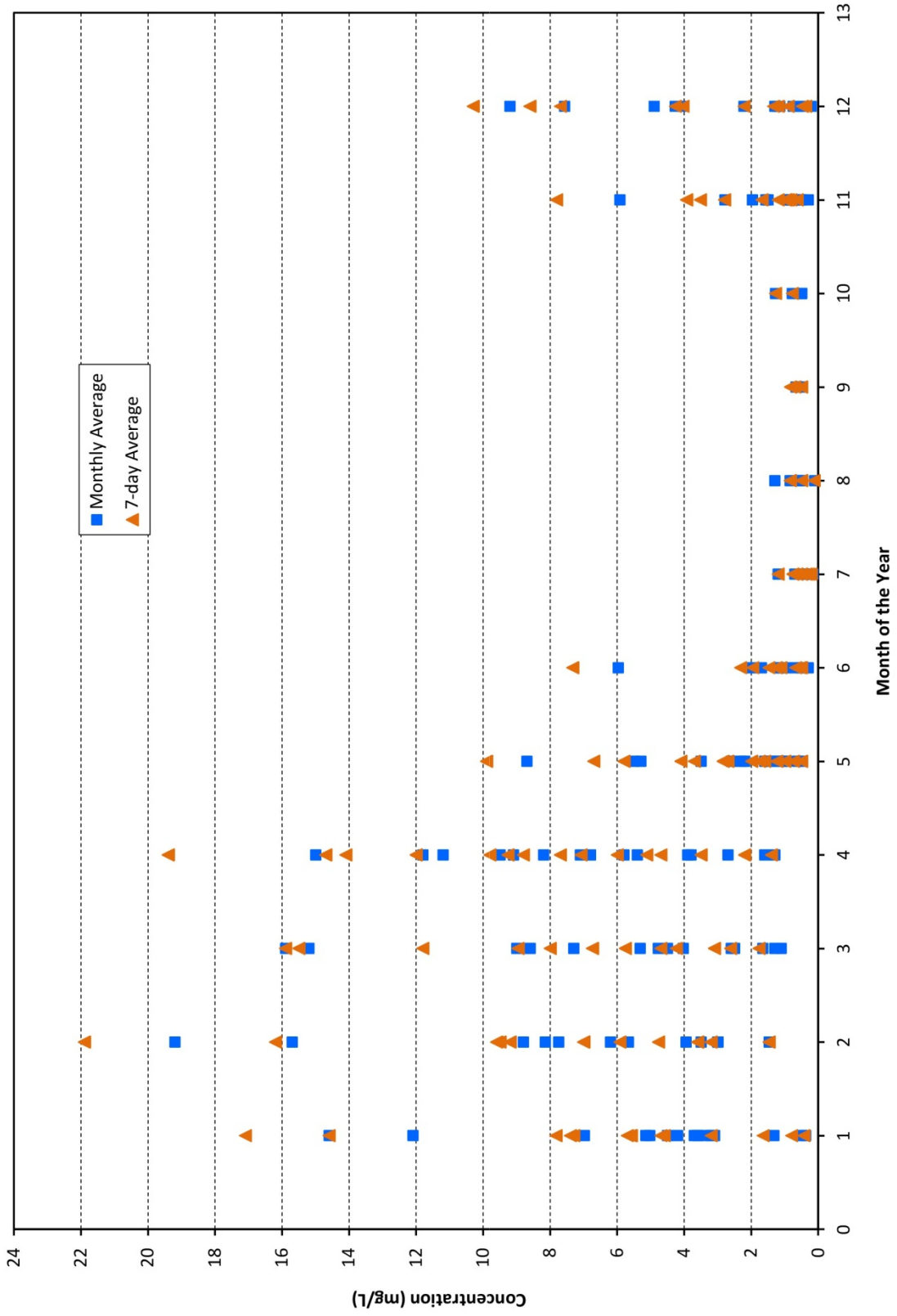

Figure 2. Seasonal plot of effluent ammonia nitrogen for Sheridan .

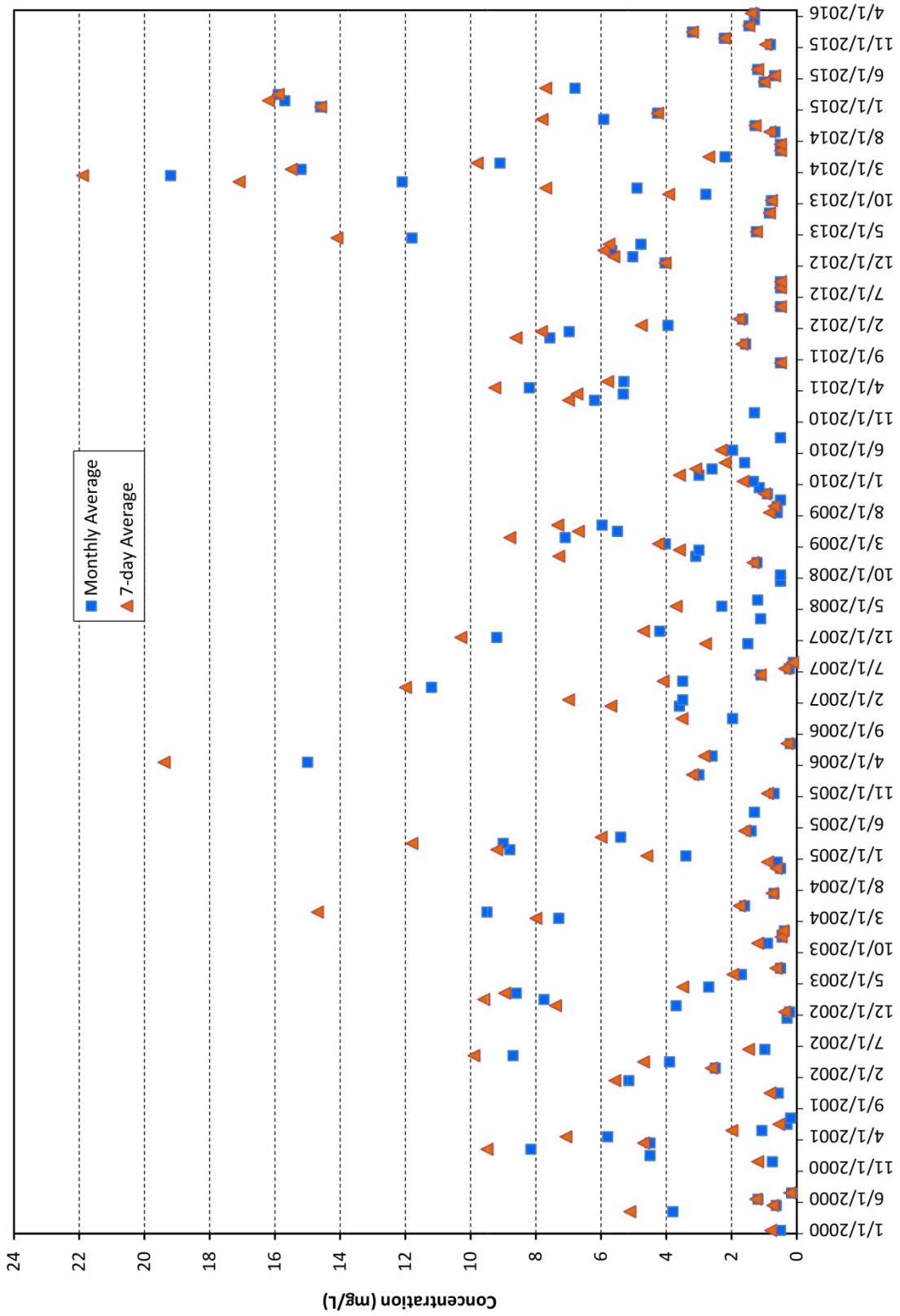

Figure 3. Long term plot of effluent ammonia nitrogen for Sheridan .

4.0 EVALUATION OF ALTERNATIVES

4.1 Ammonia Removal Processes in Wastewater Ponds

Ammonia removal in a facultative lagoon system is accomplished by several mechanisms within the lagoons. In these systems, ammonia removal can occur by volatilization, biological nitrification, and by assimilation into the algal biomass. Although a combination of these mechanisms may be at work for ammonia removal, the predominant mechanism, under favorable conditions, is losses to the atmosphere through volatilization.

The release of ammonia to the atmosphere is a function of pH, temperature, and mixing conditions (Office of Water Programs, Cal State University, p. 2). Below a pH of 9.25, aqueous inorganic ammonia primarily exists as ammonium (NH_4^+), which is ionically held in solution. Above pH 9.25, inorganic ammonia changes to ammonia (NH_3), which is gaseous and will volatize. This equilibrium between NH_4^+ and NH_3 is shown graphically in Figure 4.

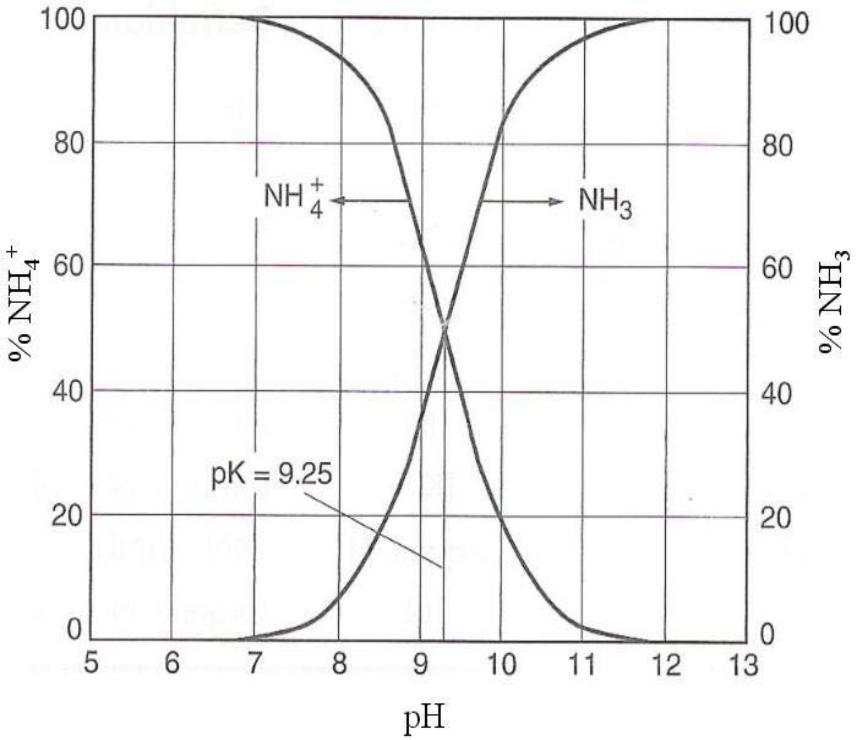

Figure 4. Graph of equilibrium between ammonium (NH_4^+) and ammonia (NH_3).

The volatilization of ammonia in ponds is made possible by the presence of algae. As carbon dioxide is consumed by photosynthesizing algae, the pH of the wastewater increases and shifts the ammonia/ammonium equilibrium toward ammonia. However, algae are normally at a minimum during the winter months when water temperatures are cold. During this season, the primary ammonia removal mechanism shifts from volatilization to biological nitrification. However, nitrifying bacteria also grow slowly when water temperatures are cold. Thus, conditions for ammonia removal are reduced during prolonged cold weather. These conditions have resulted in Sheridan exceeding effluent ammonia nitrogen limits during the winter months of 2014 and 2015.

4.2 Review of Data Collected During Winter 2015 – 2016

The water quality data that were collected during December 2015 – March 2016 are presented in Section 2 above. These data were collected in order to better understand how nitrification can be improved during cold weather conditions.

Influent concentrations of ammonia were not measured but are expected to be significantly higher than the values measured in the flow leaving the first pond. Therefore, significant reductions of ammonia occurred in the first pond. For the second pond, though, the concentrations leaving the second pond were either similar to or only slightly lower than the concentrations entering that pond; thus, only minimal ammonia reductions occurred in the second pond.

4.3 Biological Treatment Alternatives

Various manufacturers of wastewater treatment equipment were contacted regarding alternatives for improving nitrification during cold weather. These alternatives consisted primarily of increasing DO for the nitrifying bacteria and/or providing additional surface area on which the bacteria prefer to grow. Information was obtained and reviewed for the following treatment options:

- Wastewater Compliance Systems (WCS) – WCS manufactures and sells patented submerged aerated bio-film reactors (Bio-Shell). These Bio-Shells provide an aerated fixed surface for improving nitrification in treatment pond systems.

- S&N Airoflo – S&N Airoflo manufacturers a floating BioFlo nitrification rotor. The BioFlo is a partially submerged attached growth treatment unit that can achieve nitrification under certain pond conditions. The treatment unit has a cylindrical cage, which contains a polypropylene host media for nitrifiers. The cage rotates at a slow revolution per minute alternating the contact of the media with the wastewater then the air. A brush aerator would be installed in close proximity to the BioFlo unit.

- Absolute Aeration, LLC – Absolute Aeration manufacturers the Blue Frog system for upgrading existing lagoon treatment systems. The Blue Frog is a low horsepower unit that can provide both pond mixing and passive aeration.

Each manufacturer provided a preliminary equipment cost (excluding installation costs) for their recommended system. Upon evaluating each system and considering both the equipment and installation costs, the systems identified above were determined to not be cost effective to address a situation that occurs infrequently. In some instances, it was inconclusive if the treatment technology could achieve the required treatment goals during the winter months.

Other technologies exist for upgrading lagoon treatment systems to achieve cold weather nitrification. However, several of these systems are "add-on" treatment steps (i.e., Nelson Environmental, Triplepoint Water Technologies, etc.) that would have resulted in a significant capital investment by Sheridan. Therefore these systems were not considered viable options. It was not considered a wise use of public resources to spend hundreds of thousands of dollars for wastewater equipment that would be needed only for a few months at a time and not every year.

4.4 Other Treatment Alternatives

The two non-biological alternatives that were identified were enhanced volatilization ("stripping") or using breakpoint chlorination to chemically oxidize the ammonia.

As discussed in Section 4.1, effective volatilization of ammonia requires a high pH so that a large portion of the total ammonia is in the form of NH_3 instead of NH_4^+. Typical pH values in Sheridan's ponds during winter are around 7.0 to 7.5. To achieve significant ammonia removal by volatilization, the pH would have to be increased by adding chemicals. If inorganic

chemicals are added to the treatment process, Sheridan's permit limit for pH could not exceed 9.0 according to federal regulations at 40 CFR 133.102. Because the pH would have to be raised above 9.0 (or higher) to achieve effective volatilization, the effluent would not meet a permit limit of 9.0 without lowering the pH using other chemicals. This alternative was not considered viable for Sheridan.

Breakpoint chlorination is an ammonia removal mechanism that has been used on a limited basis in the U.S. for several decades. It is not widely used due to the cost of the large amounts of chlorine that are necessary if it is used on a continuous basis as the primary removal mechanism for ammonia. Sheridan, though, only needs a system that would be used for several months at a time and not every year. The initial cost for a chlorination system is much less than the biological treatment alternatives that were proposed by vendors.

5.0 SELECTED ALTERNATIVE

5.1 Install Four Aerators in Second Pond

Sheridan's selected alternative includes placement of four aerators in the second pond – two on each side of the existing baffle curtain (see Figure 1). This selection is based on the water quality data that showed minimal ammonia reductions in the second pond (see Section 4.2). It is believed that limited system improvements to the second pond could sufficiently decrease overall ammonia concentrations in a more cost effective manner than the large scale installations proposed by the vendors. The anticipated benefits of these aerators include:

- Increase DO – Over 4 lbs of oxygen are required to convert 1 lb of ammonia to nitrate through nitrification. These aerators will help maintain DO when photosynthesis by algae decreases in the fall and winter months of the year.

- Increase mixing – Good mixing provides contact between nitrifying organisms and ammonia in solution.

- Cold weather operation – The aspirating aerators that Sheridan is planning to use are less likely to be affected by ice buildup than the existing paddlewheel aerators in the first pond.

In order to provide assurance that these aerators are sufficient, Sheridan will collect water quality data (primarily ammonia concentrations) for the wastewater entering and leaving the second pond during the winter of 2016 – 2017. If these aerators do not reduce ammonia concentrations enough to meet permit limits at the outfall, Sheridan's progress report to ADEQ (see Table 5 below) will include a proposal for additional measures to achieve compliance.

5.2 Evaluate Breakpoint Chlorination as Contingency Measure

As a potential contingency measure for ammonia reduction during prolonged periods of low temperatures, breakpoint chlorination will be evaluated. The first step in evaluating breakpoint chlorination as an alternative will be to obtain a determination from ADEQ whether or not Sheridan would be allowed to maintain a pH limit of 10.0 during summer even if inorganic chemicals (chlorine) were added during the winter. It is Sheridan's understanding that the federal regulations at 40 CFR 133.102 do not include any prohibition for applying the requirements on a seasonal basis (i.e., evaluating different seasons independently). If ADEQ will not allow Sheridan to maintain a pH limit of 10.0 during summer, breakpoint chlorination will not be a viable option and will not be pursued.

Assuming ADEQ will allow Sheridan to maintain a pH limit of 10.0 during summer, laboratory bench scale testing will be performed during the winter of 2016 – 2017 to determine the effectiveness of breakpoint chlorination during winter conditions. The bench scale testing will also be used to evaluate the potential for adverse impacts to the holding pond and effluent discharged through the NPDES outfall. This testing must be done during winter because wastewater in the ponds has different water quality (e.g., algae and ammonia) in winter than in summer.

If these bench scale tests yield favorable results, Sheridan will proceed with the submittal of a State Construction Permit application for installation of a full scale system to be used as needed. Details of the system would be developed later and included in the Construction Permit application, but it is currently anticipated that the chlorination system would be located where the wastewater flows from the second pond to the holding pond. The large surface area and long retention time in the holding pond would provide opportunity for any residual chlorine to escape into the air.

6.0 SCHEDULE

Sheridan proposes to move forward with the selected alternative according to the schedule outlined in Table 5.

Table 5. Schedule for implementing selected alternative and achieving compliance.

Milestone	Completion Date
Installation and start-up of four aerators in second pond (assuming that a State Construction Permit is not required)	December 2, 2016
Collection of water quality data in second pond	March 31, 2017
Submit progress report to ADEQ describing the performance of the second pond during winter 2016 – 2017	April 28, 2017
Apply for a State Construction Permit for the chlorination system*	April 28, 2017
Installation of chlorination system*	Six months after Construction Permit is issued

* If ADEQ allows a pH limit of 10 during summer and bench scale testing results are favorable.

The date for final compliance for ammonia nitrogen will be as described below:

1) When installation of the chlorination system is complete (if ADEQ allows a pH limit of 10 during summer and bench scale testing results are favorable), or

2) April 28, 2017 (if a chlorination system is not installed, and water quality data from the second pond during winter 2016 – 2017 show sufficient ammonia reductions to meet permit limits at the outfall, or

3) December 1, 2017 (if a chlorination system is not installed, and water quality data from the second pond during winter 2016 – 2017 show that additional measures are needed). This assumes prompt issuance of any necessary Construction Permit.

Although this schedule may appear to be long, it should be noted that Sheridan has not had any permit limit exceedances for ammonia since March 2015. In other words, the facility is

currently in compliance with permit limits for ammonia and does not expect any exceedances unless an exceptionally cold winter occurs prior to implementing improvements.