OPERATION AND MAINTENANCE PLAN

Artesian Northern Sussex Regional Water Recharge Facility (ANSRWRF)

July 17, 2019

PREPARED FOR:

ARTESIAN WASTEWATER MANAGEMENT, INC.

664 Churchmans Road

Newark, DE 19702

PREPARED BY:

ARTESIAN RESOURCES CORPORATION

664 Churchmans Road

Newark, DE 19702

DANIEL W. KONSTANSKI LICENSE No. 18462 DELAWARE PROFESSIONAL ENGINEER

Daniel Konstanski, P.E.

Principal Engineer

Artesian Resources Corporation

7/17/19

Table of Contents

1 - Executive Summary

1.1 Overview

§6.7.2.2.1

1.1.1 Project Narrative

ANSRWRF is envisioned to serve as a regional facility meeting current and future wastewater needs within the Artesian Wastewater Management, Inc. (AWMI) service territories in Sussex County. The facility will be owned and operated by AWMI.

Phase 1 of the project is to construct a storage lagoon and disposal spray fields, and to accept treated wastewater effluent from Allen Harim Foods, LLC (Allen Harim). The design average daily flow is 1.5 MGD with a peak flow of 2.0 MGD.

Phase 1 disposal fields include Fields D, E, F, and G. However, construction has not been completed on Fields D and E. These fields are not required to dispose the Phase 1 volume, but are intended to be available to provide additional operational flexibility. As construction has not been completed, Fields D and E will not be permitted for operations in the initial Operations Permit. Once construction and all applicable background monitoring has been completed, AWMI will request authorization from DNREC to commence spray operations on these fields. The format and documentation of this request will be as stipulated by DNREC. **Throughout this manual, any references to spraying on Fields D and E are contingent on the applicable authorization having been granted.**

The proposed facility will utilize reclaimed wastewater for irrigation of privately owned agricultural land, under a lease held in perpetuity by AWMI as the wastewater utility provider. The proposed irrigation sites, including current and future phases, total approximately 1,714 acres of land which includes both wooded and agricultural area. These sites have been permanently placed in an Agricultural Preservation Easement by the Delaware Agricultural Lands Preservation Foundation.

The effluent will receive a high level of treatment to meet the "Unlimited Public Access" requirement. For Phase 1, the treatment for Unlimited Public Access will be provided by Allen Harim. Nitrogen polishing will be accomplished through crop uptake to meet the requirements of PSN2.

This O&M Manual is based on the ANSRWRF Amended Design Development Report (DDR) signed May 5, 2017, including Addendum 1 signed August 18, 2017, and the DNREC Construction Permit #359288-01 which was issued with an amended date of November 3, 2017.

Note: throughout this manual, applicable sections in the regulations are provided for ease of review using the notation **§6.5,** in reference to the DNREC Regulations Governing the Design, Installation and Operation of On-Site Wastewater Treatment and Disposal Systems, as amended January 11, 2014. These are not intended to provide an exhaustive cross-referencing.

1.1.2 Process Design Summary

1.1.2.1 Compliance Monitoring Point

For Phase 1, where treatment is being performed at the Allen Harim facility, the point of compliance for BOD_5, TSS, and disinfection as described in **§6.3.2.3.2** is at the sampling station on the Allen Harim site, which meets the requirement for the point of compliance to be after treatment and prior to storage. See also Section 3.1.2.

A storage lagoon of at least 4 million gallons (2-days) will be provided by Allen Harim on-site in accordance with **§6.3.2.3.2.4**, so that non-conforming effluent can be diverted and retreated prior to being routed to the ANSRWRF facility. See Section 3.5 for more information.

See Section 3.5 for a discussion of the protocols for monitoring and responding to non-compliant water.

1.1.2.2 Influent Flow

Influent flow enters a manhole in the storage lagoon wall via a 16-inch force main, and flows by gravity through a 24-inch pipe to enter the lagoon from the bottom in an upflow configuration. For Phase 1, influent flow is metered at the Allen Harim site and connected to the AWMI SCADA system for remote viewing.

1.1.2.3 Storage Lagoon

The storage lagoon receives treated water and is lined with a reinforced polypropylene liner. This lagoon will provide storage of filtered wastewater prior to being land applied. The storage lagoon will have the ability to store 92 million gallons of water to manage seasonal demands throughout the land application system. The lagoon has a high water level of 43.0 feet, with an additional three feet of freeboard, and a low water level of 26.0 feet. See Table 1-1 for details.

No mechanical aeration is required in the storage lagoons since the incoming BOD_5 will be well below 25 pounds/acre-day and aerobic conditions will be maintained via natural oxygen transfer. However, two 75-HP floating aerators are included, with provisions for an additional two aerators to be added if needed. The aerators are mounted on a mooring frame with power supplied by a cable with fiberglass floats. These aerators are intended for general mixing of the basin to minimize stagnation.

Table 1-1: Storage Lagoon Stage-Storage

Elevation (ft)	Wet Well Depth (ft)	Cumulative Storage (MG)	Notes
14.5	0	0	Invert Of Pump Station Wet Well.
19.75	5.25	0	Invert of Suction Chamber.
26	11.5	0	Minimum Water Level for Pump Operation.
26.5	12.0	1	
27	12.5	3.2	
28	13.5	8.3	
29	14.5	13.4	
30	15.5	18.7	
31	16.5	24.0	
32	17.5	29.3	
33	18.5	34.8	
34	19.5	40.2	
35	20.5	45.8	
36	21.5	51.4	
37	22.5	57.1	
38	23.5	62.9	
39	24.5	68.7	Phase 1 Limit. Not to exceed without DNREC Authorization.
40	25.5	74.6	
41	26.5	80.5	
42	27.5	86.5	
43	28.6	92.6	High Water Level. Not to exceed without DNREC Authorization.
44	29.5	98.8	Freeboard.
45	30.5	105.0	Freeboard.
46	31.5	113.3	Freeboard.

1.1.2.4 Spray Irrigation Pump Station

The pump station consists of three vertical turbine pumps that are each 300 HP and with a design point of 3,750 gpm at 220 feet. These pumps have Variable Frequency Drives and are programmed to maintain a constant pressure on the downstream force main, and are operated with two duty and one backup on a rotating schedule. Provisions are included for a future vertical turbine to provide plant water onsite as needed. The pumps are fed from a 24-inch suction pipe with three 18-inch self-cleaning suction screens. A cleanout is provided to allow water to be back-fed through the screen.

A 24-inch main delivers treated effluent from the pump station to the irrigation fields. The pressure requirements for the various spray center pivots and solid set zones differ, so the pump station will be set to maintain sufficient pressure for the highest required pivot plus headloss, and pressure reducing valves are included at each center pivot and zone to maintain the required pressure.

1.1.2.5 Supplemental Chlorination

Supplemental chlorination may be injected into the effluent from the storage lagoon using sodium hypochlorite tanks. This is intended as an optional tool for the operators to use as needed for algae

control. Yard piping and valving is set up such that flow can be circulated back to the lagoon influent, so that mixing and additional disinfection can be provided as needed to address operational challenges.

Final sizing of the permanent tanks and chemical feed pumps will be completed after startup and initial operations. In the interim, if chlorination is necessary, the two 350 gallon temporary tanks may be connected to the existing injection port with temporary pumps.

1.1.2.6 Disposal System

The disposal system for Phase 1 consists of spray irrigation on crops and woods. Irrigation to crops will be supplied through center pivots, and irrigation to woods will be supplied through solid set sprinkler nozzles. Each center pivot and each zone of solid sets is controlled through a pressure reducing valve and flow meter. The pressure reducing valves can be opened and closed remotely to provide dosing according to the operational strategy. The force main diameter is stepped down at each field as needed.

The program facilitates irrigation within the weather constraints and allows the soil to fully aerate between irrigation periods. Controls at the operations building allows the operator to automatically control daily initiation and cessation of irrigation. The maximum duration of pump time is adjusted on a monthly basis to limit application to the monthly design loading rates.

Each center pivot irrigator connects to a pressurized central pipe system through which the treated effluent is pumped from the automatic variable speed pumping station at the treatment plant. Automatic control valves and pressure regulating valves at each center pivot ensure the appropriate volume of treated effluent is discharged to each center pivot irrigator at the appropriate system pressure. A low pressure detection system is installed to automatically shut down the irrigation operation in the event of a force main failure.

The design value for total nitrogen in the influent to the lagoon is higher than the ANSRWRF permit level of 10 mg/L total nitrogen in the groundwater percolate beneath the spray irrigation areas. The final level for treatment of nitrogen involves the effects of denitrification, ammonia volatilization, and plant uptake. Nitrogen levels in the percolate will be managed by adjusting spray irrigation rates according to the design and reporting spreadsheets. Lysimeter sampling results and groundwater monitoring trends can be used to validate the design assumptions.

Table 1-2: Disposal Field Summary

Field	Tax Map ID	Gross Area (acres)	Crop Spray Area (acres)	Woods Spray Area (acres)	Total Spray Area (acres)
A[1]	230-22.00-1.00	182.9	116.3	34.1	150.4
B[1]	230-21.00-13.00 230-21.00-35.00 230-21.00-35.01	412.8	214.1	86.3	300.4
C[1]	235-7.00-27.00	157.5	37.0	38.2	75.2
D[2,3]	235-6.00-11.00 235-6.00-11.01 235-6.00-11.02 235-7.00-1.00 235-7.00-164.00	125.1	58.0	32.7	90.7
E[2,4]	235-6.00-21.00	119.0	90.5	0	90.5
F	235-7.00-7.00	126.5	110.5	0	110.5
G	235-13.00-6.05 235-13.00-6.06	590.5	276.1	200.5	476.5
Total		1,714.27	902.5	391.8	1294.19

1) Spray areas based on preliminary design for Design Development Report dated June 19, 2009. These will be designed and permitted during a future phase.
2) Fields D and E have not yet been constructed. See discussion in Section 1.1.1.
3) One parcel from Field D (2-35-6-11.01) is not included in the current Conditional Use Ordinance 1923, adopted July 31, 2017. Spray will not commence on this parcel until it has been added to an approved Conditional Use.
4) There is a wooded region in Field E of approximately 10 acres which is not included in the existing design, but may be utilized in future phases.

Table 1-3: Phase 1 Disposal Field Zone Details

Zone	Type	Target	Wetted Area (Acres)	Volume of 1.65 Inches (MG)[1]	Status
D-100	Solid Sets	Woods	32.69	1.46	Future
D-1	Center Pivot	Crop	45.29	2.03	Installed
D-2	Center Pivot	Crop	3.25	0.15	Future
D-3	Center Pivot	Crop	5.48	0.25	Future
D-4	Center Pivot	Crop	4.01	0.18	Future
E-1	Center Pivot	Crop	83.16	3.73	Installed
E-2	Center Pivot	Crop	1.72	0.08	Future
E-3	Center Pivot	Crop	5.60	0.25	Future
F-1	Center Pivot	Crop	30.1	1.35	Installed
F-2	Center Pivot	Crop	80.36	3.60	Installed
G-1	Center Pivot	Crop	140.04	6.27	Installed
G-2	Center Pivot	Crop	43.43	1.95	Installed
G-3	Center Pivot	Crop	58.39	2.62	Installed
G-4	Center Pivot	Crop	20.78	0.93	Installed
G-8	Center Pivot	Crop	13.42	0.60	Installed
G-100	Solid Sets	Woods	10.8	0.48	Installed
G-101	Solid Sets	Woods	10.8	0.48	Installed
G-102	Solid Sets	Woods	10.8	0.48	Installed
G-103	Solid Sets	Woods	10.8	0.48	Installed
G-104	Solid Sets	Woods	7.00	0.31	Installed
G-105	Solid Sets	Woods	6.74	0.30	Installed
G-106	Solid Sets	Woods	11.58	0.52	Installed
G-107	Solid Sets	Woods	9.41	0.42	Installed
G-108	Solid Sets	Woods	13.74	0.62	Installed
G-109	Solid Sets	Woods	11.20	0.50	Installed
G-110	Solid Sets	Woods	11.20	0.50	Installed
G-111	Solid Sets	Woods	11.20	0.50	Installed
G-112	Solid Sets	Woods	11.58	0.52	Installed
G-113	Solid Sets	Woods	11.20	0.50	Installed
G-114	Solid Sets	Woods	11.20	0.50	Installed
G-115	Solid Sets	Woods	11.20	0.50	Installed
G-116	Solid Sets	Woods	10.94	0.49	Installed
G-117	Solid Sets	Woods	9.67	0.43	Installed
G-118	Solid Sets	Woods	9.41	0.42	Installed

1) Reference value only. Maximum allowable spray volumes are dependent on permit requirements including, but not limited to, currently active wetted area and the monthly Nitrogen Balance.

1.1.3 Design Flow Characteristics

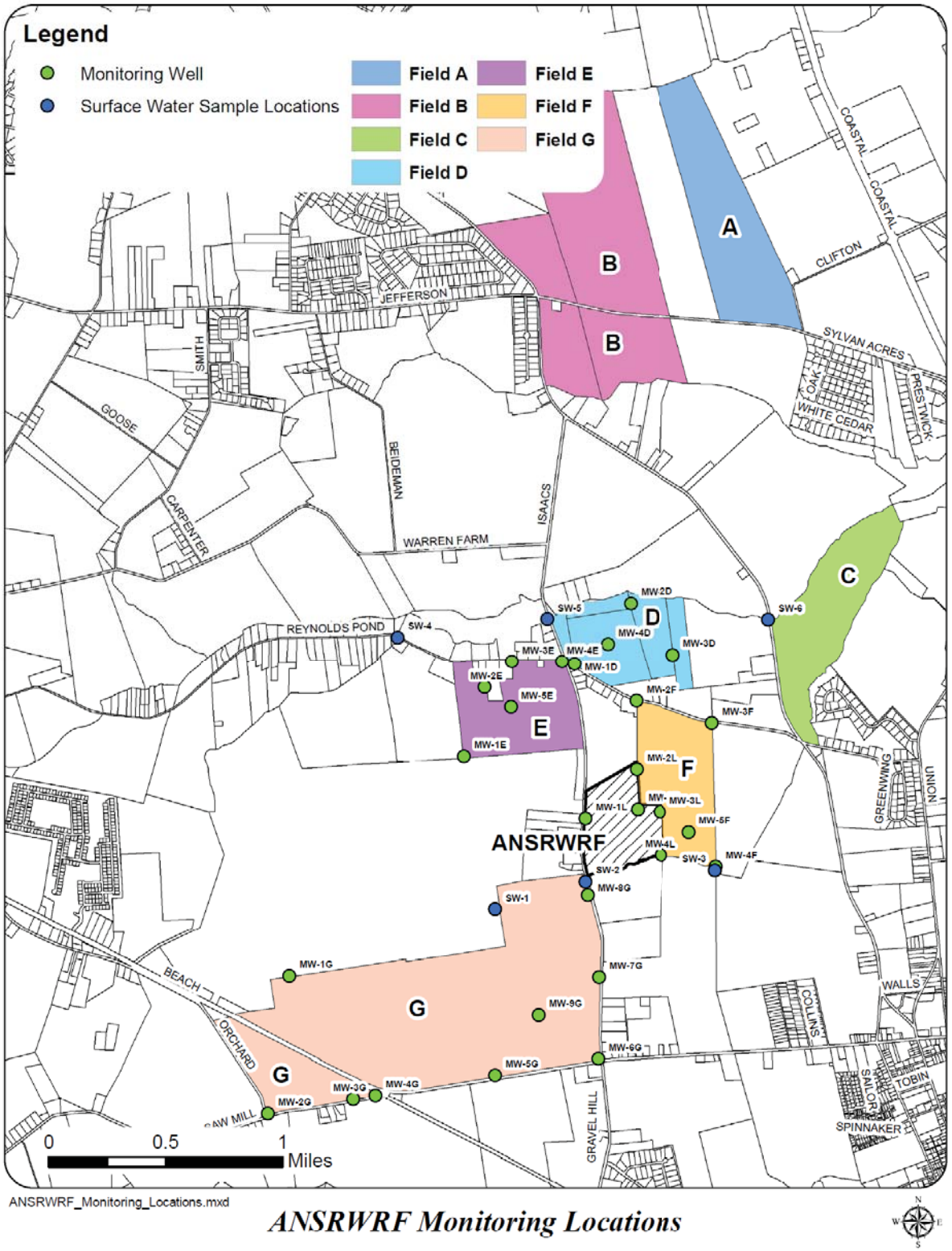
Table 1-4: Phase 1 Design Influent Parameters

Parameter	Value	Units
Average Daily Flow	1.5	MGD
Peak Daily Flow	2.0	MGD
BOD_5	10	mg/L
Total Suspended Solids	10	mg/L
Turbidity	5	NTU
Fecal Coliform	20	col/100 mL
Total Nitrogen (as N)	30	mg/L
Ammonia (as N)	0	mg/L
Nitrate/ Nitrite (as N)	28	mg/L
Total Phosphorus	1.0	mg/L
Lead	0.001	mg/L
Zinc	0.039	mg/L
Copper	0.0072	mg/L
Nickel	0.005	mg/L
Cadmium	0.0005	mg/L
Aluminum	0.2	mg/L
pH	6.0-9.0	S.U.
Chlorine Residual	0.5-4	mg/L

1) With the exception of Peak Daily Flow, these design values represent monthly averages.

1.2 Overview Map

§6.7.2.2.1.2



Note: Buffer zones, streams, and irrigation layouts are shown on the attached construction plans.

1.3 Collection System Plans

§6.7.2.2.1.3

See Appendix D.

1.4 Treatment System Plans

§6.7.2.2.1.4

Not applicable for Phase 1. Treatment will be performed by Allen Harim under a separate operations permit.

1.5 Disposal System Plans

§6.7.2.2.1.5

See Appendix E.

1.6 Current Operations Permit

§6.7.2.2.1.6

Not applicable. Operations permit will be appended to Appendix A once it is issued.

1.7 Relevant DNREC Permits

§6.7.2.2.1.7

See Appendix A.

1.8 Management and Staffing

§6.7.2.2.2

AWMI is a Responsible Management Entity (RME) as defined in Delaware Administrative Code 7204: Regulations for Licensing Operators of Wastewater Facilities. As such, the management and staffing is shared between multiple Wastewater Treatment Facilities as described in a Quarterly Report submitted by AWMI to DNREC.

A copy of the most recent Quarterly Report is included in Appendix A. This will be updated by the Manager of Wastewater Operations as needed. For Phase 1, ANSRWRF is anticipated to be classified as a Class I Facility. See Section 2.10 and Table 2-4 for additional information on staff responsibilities.

The Table 1-5 is a preliminary outline of the expected staffing requirements for the ANSRWRF Facility. These may be adjusted by the Manager of Wastewater Operations as needed.

Table 1-5: Management and Staffing

Position	Number of Positions	Duties and Responsibilities	Qualifications, Experience, and Training	Work Hours
Direct Responsible Charge (DRC)	1	Primary responsibility for daily operations and reporting. Coordination of all sampling and reporting requirements.	Level 4 Wastewater Operations License	Monday - Friday, 0700-1530.
Backup DRC	1	Primary responsibility for daily operations and reporting in the absence of the DRC.	Level 4 Wastewater Operations License	Normally in rotation with other Level 2 Operators.
Level 2 Operator	3	Daily operations. During hours of extra coverage personnel will perform sampling including influent and effluent, lagoon, monitoring well, piezometer, lysimeter, and surface water.	Level 2 Wastewater Operations License	1st shift 0600-1430. 2nd shift 1100-1930. One pair working Sunday through Thursday, one pair working Tuesday through Saturday.
Level 1 Operator	1	Daily operations. Covers operations for vacations, sick time, and training.	Level 1 Wastewater Operations License	As Needed
Maintenance Personnel	4	Performs inspection and maintenance activities. During Wednesday's double coverage, preventative and proactive maintenance will be performed.	Varies. To be determined by Manager of Wastewater Operation.	1st pair Sunday through Wednesday, 0700-1730. 2nd pair Wednesday through Saturday, 0700-1730.

1) DRC and Operator Qualifications, Experience, and Continuing Education Training requirements for each License Level are specified in the DNREC Regulations for Licensing Operators Of Wastewater Facilities.

2 - System Operation and Maintenance

2.1 Treatment System Operation and Maintenance

§6.7.2.2.3.1

Not applicable for Phase 1. Treatment will be performed by Allen Harim under a separate operations permit.

2.2 Disposal Facility Design Life

§6.7.2.2.3.2.1

The design life for spray irrigation is primarily determined by the long-term build-up of land limiting constituents, as defined in **§6.3.2.3.8**. These constituents include Lead, Zinc, Copper, Nickel, Cadmium, and Phosphorus. The expected land limiting constituent identified in the DDR was Zinc, with a site life expectancy of 93 years. See Appendix C for calculations.

Factors that could impact the site life are primarily a long-term increase in influent concentrations above the design values.

Conditions which would indicate that phosphorus has become the land limiting constituent include a rise in phosphorus concentrations in groundwater monitoring tests or phosphorus adsorption tests indicating that the adsorption capacity of the upper 24 inches of soil has decreased to a level that is insufficient to assimilate excess phosphorus.

Conditions which would indicate that one of the metals has become the land limiting constituent would be soil test results approaching the limits set forth in the regulations in **§Exhibit HH**.

These conditions will be evaluated for the groundwater and soil samples according to the monitoring schedule in the Operations Permit. If a limiting condition is approaching on a particular disposal area, provisions will be made to reduce or eliminate flow to that area and additional area brought into service prior to the condition being exceeded.

2.3 Start-Up and Shut-Down Procedures

§6.7.2.2.3.2.2

This section describes the procedures for initial startup, and for start-up and shut-down related to extended periods without operation. The ANSRWRF system has been designed to be operated continuously with no long-term shutdowns except as necessary for weather conditions such as freezing.

Once all individual components are accepted and approved for use by DNREC, they will be officially commissioned and brought into service together. Individual systems will be brought online in accordance with manufacturer's specifications. Individual components which must be brought out of service for maintenance or replacement will be shut down in accordance with the manufacturer's specifications and AWMI safety protocols.

Equipment will be started and operated based on manufacturer's recommendations. See equipment-specific O&M Manuals in Appendix F.

2.3.1 Lagoon

No special procedures are required for the start-up or shut-down of the lagoon.

2.3.2 Aerators

The minimum water elevation for aerator operation is 26.0 feet above sea level, which corresponds to a pumping station water depth of 11.5 feet. The aerator will automatically turn off when water depth is lower than the setpoint. See equipment-specific O&M Manuals in Appendix F.

2.3.3 Pump Station

The minimum water elevation for pump operation is 26.0 feet above sea level, which corresponds to a pumping station water depth of 11.5 feet. The pumps will automatically turn off when water depth is lower than the setpoint. Before the operator starts the operation of the pump station or places it back into operation after an extended shut-down, they will read and understand all portions of the manufacturer operation and maintenance literature. The following will also be checked:

1. Pipe connections for tightness.
2. All valves for proper operation. All gate valves must be fully opened for normal operation.
3. All equipment is lubricated.
4. Cleanliness of wet well.
5. Float and control system.
6. Proper piping installation.
7. Each pump will be started and checked for signs of problems.
8. To start the pump station:
    a. Turn the HOA switch to off position and then turn on the main circuit breakers.
    b. Open all discharge valves.
    c. Open at least one center pivot valve or solid set zone.
    d. Turn HOA switch to hand position on the jockey pump and notice operation. Check for noise and vibrations.
    e. Turn HOA switch to hand position on one of the irrigation pumps and notice operation. If pump is noisy, vibrates, or does not pump see troubleshooting guide. Repeat for all pumps.
    f. Now set HOA switches to automatic.
    g. Open one, two center pivot valves. Notice lights and pressure. Repeat with remaining pivots and solid set zones.
    h. Turn HOA switches to off and allow wet well to fill. Check for alarm.
    i. Check voltage when pumps are operating and check amp draw of each pump.
    j. Ensure check valves seats properly when pump is not in operation.
    k. Place pumps into auto position for normal service.

2.3.4 Chlorination and Recirculation

Sodium Hypochlorite solution may be injected into the wastewater stream after the lagoon and cycled back to the lagoon to assist with algae control and odor control. To provide circulation, close the isolation valves leading to the spray irrigation sites and open the isolation valves leading to the inlet of the lagoon. Chlorine pumps may require priming. Trial and error testing will be required to determine chlorine dose necessary without over chlorination. The dosage will vary during the year.

2.3.5 Center Pivots and Solid Sets

Verify that all pressure reducing valves controlling flow to the center pivots and solid sets are in the closed position. Verify all irrigation system isolation valves leading from the lagoon to the disposal area have

been opened and will allow water to be distributed to all segments of the system, and that the recirculation isolation valves leading from the pump station back to the inlet of the lagoon are closed. Manually control flow until pressure sustaining valve is operated and provides sufficient back pressure to operate the center pivot irrigation system.

2.4 System Maintenance

§6.7.2.2.3.2.3-5

Routine yard maintenance, regular mowing of the lagoon embankments, removal of weeds, and floatable debris will be performed on a routine basis. Embankments and rip-rap will be inspected for burrowing animals. General site maintenance as well as equipment inspection and maintenance schedules are shown in Table 2-4. These schedules may be revised as needed by the Manager of Wastewater Operations. See also the individual equipment O&M Manuals in Appendix F.

2.5 Procedures for Adverse Conditions

§6.7.2.2.3.2.6

In general, when conditions allow, effluent will be discharged to available fields at the maximum rates as limited by permit conditions and agreements with the crop farmer. This will keep the lagoon level as low as possible which will maximize the available flexibility for responding to adverse events.

2.5.1 Nuisance Odors

Nuisance odors are not anticipated, as the effluent is treated to the level of Unlimited Public Access. However, should odors be present, aerosols or nuisance odors shall not extend beyond the boundary of the spray irrigation site when treated wastewater is being applied. If odors are produced that are considered to be a public nuisance, the permittee will take the necessary steps to eliminate such odors, such as recirculation and chlorination. See Section 2.3.4 for details. All action taken will be reported to the Department.

2.5.2 Wet Weather and Ponding

The spray fields will be maintained in such a manner as to prevent wastewater pooling and/or discharge of wastewater to any surface waters. Should pooled areas become evident, spraying on those areas will be prohibited until saturated conditions no longer exist. The permittee will notify the Department immediately if any wastewater runoff occurs.

Special attention will be paid to the wooded portions being sprayed so as to maintain good stands and avoid oversaturation of the root systems.

2.5.3 High Groundwater

Observation wells (piezometers) will be installed to measure seasonal high-water levels. Each observation well will include a screen set across the water table. A float and dowel system will be installed in each observation well to float on the water table. The dowel will be inserted through the well cap into the float. The dowel will then be color coded to indicate depth to water (DTW) with green being DTW greater than 3 feet below grade, yellow being DTW from 3 to 2 feet below grade, and red being depth to water less than 2 feet.

While performing the monitoring described in Section 3.2.1, if the Depth to Water Table in any one of the monitoring wells has reached within 3 feet of the ground surface, the observation wells on the field in question will be observed weekly if spray is being conducted. The operators will discontinue spraying to

the areas adjacent to the observation well if DTW reaches 2 feet (red coded). The spray fields will be restarted only after the DTW is greater than 2 feet (yellow coded). Weekly sampling may be discontinued when the DTW for all observation wells in the field in question are greater than 3 feet (green coded).

2.5.4 Freezing Weather

Spray irrigation will be suspended when frozen soil conditions exist. The irrigation force main system will be drained prior to anticipated freezing conditions to prevent pipe rupture.

Above ground disposal lines are equipped with automatic drains which will drain the lines whenever they are not in use. Riser pipes are equipped with a drain as well which will be activated whenever the isolation valve to the lane is closed. Prior to freezing temperatures wastewater operators will manually close all of these valves and the pipelines will drain automatically protecting them from freezing. Once temperatures are back up to acceptable levels the lines will be manually re-opened and spray operations will re-commence.

2.5.5 Saturated Soil

Spray irrigation will be suspended when saturated soil conditions exist.

2.5.6 Excessive Winds

During periods of high wind, the active disposal areas will be restricted to avoid off-site impacts based on wind speed and direction. Winds are considered high if speed is greater than 15 mph at the spray fields or if aerosols are observed to blow off-site.

2.5.7 Freeboard

Operators will notify the Department in writing prior to utilizing the freeboard in any lagoon or immediately upon unexpected encroachment into freeboard. In the event of encroachment into freeboard, operators will contact the Department to coordinate relief measures. In the event of an emergency, operators must immediately call the DNREC enforcement at 800-662-8802, then call the GWDS Department at 302-739-9948, followed by a letter of non-compliance within 5 days of encroachment.

2.6 Electrical and Mechanical Malfunctions

§6.7.2.2.3.2.7

As influent flow directly enters the storage lagoon with ample volume, short-term electrical or mechanical malfunctions including loss of power can be handled simply by suspending spray irrigation activities as needed until the malfunction is repaired. A backup pump provides redundancy in case extensive repairs are required. The permitted disposal area for Phase 1 includes a substantial safety factor for anticipated influent flow volumes such that malfunctions of any disposal equipment can be accommodated by utilizing different disposal area until repairs are completed.

If necessary, a portable generator and/or portable pumps could be brought on-site.

2.7 Troubleshooting

§6.7.2.2.3.2.8

The disposal pumps will be inspected and maintained according to the manufacturer's recommendations. In an event that one of them suffers a failure, the system has been designed so that a redundant pump is always available.

The two primary categories of issues with the disposal equipment are restricted flow from blockage or damage and pipe bursts. Each of these will be detectible by SCADA, either through abnormally high pressure (for blockages), abnormally low pressure (for large leaks), or discrepancies between pumped volumes and disposal zone volumes (for small leaks).

For equipment-specific troubleshooting, see product O&M Manuals in Appendix F.

Table 2-1: Lagoon Troubleshooting Guide

Problem	Possible Causes	Possible Solutions
Odors	1. Poor aeration or mixing. 2. Previous ice-covered lagoons. 3. Duckweed growth. 4. Excessive weed growth along lagoon banks harboring flies, trapping grease and organics. 5. Influent odors.	1. Increase aeration capacity. 2. Alter aerator running time, change or supplement type of aeration. 3. Increase aerator running time, change type aerator to eliminate ice cover. 4. Physical removal by pulling, mowing, burning or chemical treatment. 5. Correct at offsite treatment plant.
Algal bloom	1. Poor circulation. 2. Low chlorine concentration.	1. Increase aeration capacity. 2. Alter aerator running time, change or supplement type of aeration. 3. Increase aerator running time. 4. Utilize supplemental chlorine injection and circulate water from irrigation pump station to lagoon inlet.

Table 2-2: Pump Troubleshooting Guide

Problem	Possible Cause	Action
Motor fails to start	Loss of supply voltage.	Check voltage across all phases circuit breakers.
	Tripped line circuit breaker.	Check voltage below circuit breakers with circuit breakers closed.
	Overload trips are open.	Press restart button.
	Defective starter.	Turn selector switch to hand. Check voltage start coil. If correct voltage is measured and starter not energized, coil is defective. If no voltage is measured, control circuit is open.
	Loose or poor connections in control panel.	Make visual inspection of all connections in control circuit, or make spot circuit checks.
	Poor contact.	Open circuit breaker, close magnetic switch by hand and examine contactors and springs.

	Open line circuit in control panel.	Check voltage at connections; check magnetic contractor.
	Open circuit in leads to motor.	Check voltage at leads.
	Leads improperly connected.	Check lead numbers and connections.
Motor fails to come up to speed	Low or incorrect voltage.	Check voltage in control panel and at motor leads.
	Incorrect connection at motor.	Check for proper lead connections at motor, compare with connection diagram on motor.
	Overload hydraulic.	Check impeller setting. Check gpm against pump capacity and head.
Motor runs hot	Motor overload.	Check current draw with amp meter.
Motor vibrates	Hydraulic disturbance in discharge.	Check isolation joint in discharge piping near pump head.
Motor noisy	Worn thrust bearing.	Inspector motor bearing.
Electrical noise	Most motors are electrically noisy during the starting period. This noise should diminish as motor reaches full speed.	
Pump will not start	No power to the motor. Check for blown fuse or open circuit breaker.	Replace fuse or close breaker.
	Selector switch may be in the off position.	Turn switch to on.
	Control circuit transformer fuse may be blown.	Replace fuse.
	Overload heater on starter may be tripped.	Push to reset.
Pump will not start and overload heater strip	Ground in wiring.	Turn off power and check motor leads with megger.
	Short in motor.	Check resistance of motor windings.
	Impeller clogged or blocked.	Remove pump and clear impeller.
Pump operated with selector switch in hand position but will not operate in auto positions	Trouble in the level control or alternator relay.	Put selector switch in auto position and turn off main power. Put a jumper wire on terminal strip. Turn on power and if power starts, trouble in control. Consult control literature.
Pumps runs but will not shut off	Pump may be air locked.	Turn pump off and let set for several minutes then reset.
	Level control may be malfunctioning.	Check level control.
	Selector switch may be in hand position.	Turn to auto.
Pump does not deliver proper capacity	Discharge value may be partially closed or partially clogged.	Open valve.

	Check valve may be partially clogged.	Clear check valve of debris.
	Pumps may be running in wrong direction. Low speed pumps can operate in reverse direction without much noise or vibrations.	Switch leads.
Motor stops and then restarts after short period but overload heaters in starter do not trip	Heat sensor in the motor are tripping due to excessive heat. Impeller may be partially clogged giving a sustained overload but not high enough to trip overload heater switch.	Remove pump. Inspect and clean suction.
	Motor may be operating out of liquid due to a failed level control. Most submersible motors can operate for extended periods without water without burning up the winding but the heat sensors give motor prolonged life by controlling winding temperature.	Check controls. Replace if necessary.
	Pump may be operating on a short cycle due to water returning to sump due to a leaking check valve.	Clear check valve.
Noisy operation	Air in liquid.	Raise low water level.
	Discharge line clogged.	Remove obstructions.
	Bent shaft.	Replace shaft.
	Pump operation in extreme left or right end of performance curve.	Correction condition.
	Defective bearings.	Replace bearings.
	Impeller clogged, worn, broken or rubbing.	Correct impeller problem or replace impeller.
Pump fails to pump liquid	Insufficient liquid above pump.	Raise wet well level.
	Suction clogged.	Remove obstruction.
	Impeller clogged or broken.	Remove obstruction or replace impeller.
	Motor operating below rated speed.	Check voltage.
	Discharge line or valves clogged	Remove obstruction.
	Insufficient power.	Check power supply.
	Pump running in wrong direction.	Switch leads.
	Excessive clearance between wear rings and impeller face.	Replace wear ring when clearance reaches manufacturer's recommendations.
	Pump air bound.	Open check valve to allow priming of discharge line.
	Discharge head to high.	Check for valve closure or obstruction of pipe or valves.

2.8 O&M of Back-Up, Stand-By, and Support Equipment

§6.7.2.2.3.2.9

For Phase 1, back-up, stand-by, and support equipment includes a redundant effluent lagoon pump and more spray field area than is required. The designation of active and standby pumps will be cycled regularly to keep similar run-time on each pump. Spray will be cycled through all available fields to keep each piece of spray equipment in regular use.

2.9 Spray Irrigation System Maintenance

2.9.1 Wastewater Application

§6.7.2.2.3.2.10.2.1

Wastewater application will be in accordance with the Operations Permit limitations. To the extent practical, the timing and volume of spray irrigation on the crops will be coordinated with the crop farmer. Two spreadsheets are available to assist with operational decisions regarding application rates to each spray area. These are the Active Spreadsheet and the DNREC Annual Report spreadsheet.

The Active Spreadsheet was developed as part of the ANSRWRF Amended Design Development Report (May 5, 2017), and has been revised as needed. This is available digitally to the operators, and a sample printout is included in Appendix C. The Active Spreadsheet includes design assumptions for the nitrogen balance and lagoon storage, such as crop uptake, precipitation, and evaporation. This spreadsheet can be used as a forecasting tool to estimate lagoon levels and percolate nitrogen levels under various operational strategies.

The Active Spreadsheet includes several options that can be adjusted to match current operational strategies. These include the amount of nitrogen applied as fertilizer each month (Item 18 of the Nitrogen Balance Sheets), and the current crop (Item 29 of the Nitrogen Balance Sheets). These values shall be coordinated with the farmer on a month-by-month basis. After adjusting either of these items, the spreadsheet must be recalculated using the 'Update All Calculations' button on the Overview tab. Only tabs whose name is prefixed by "Field_" are used when updating the Storage Volume Calculations sheet. This allows engineers and operators to forecast system behavior with different fields assumed to be in service or out of service for any reason, by adding or removing the prefix from the tab name.

Note that there is a different spreadsheet for each Field, and different sheets for the Crop and Woods areas. However, for all Crop areas, the calculated Application Rate in inches will be identical if the crop and fertilizer rows are identical, and likewise for the Woods areas. In other words, the maximum amount of inches per week does not change when the total spray area changes.

Once updated, the Spray Hydraulic Application Rate (Items 10 and 11 of the Nitrogen Balance Sheets) defines the maximum number of inches per week and inches per month that may be sprayed. This assumes the concentration is below the design and permit level of 30 mg/L Total Nitrogen. If lagoon sample results described in Table 3-7 indicate higher than 30 mg/L Total Nitrogen, the Lagoon Testing protocol described in 3.5.2.2 must be followed, and the maximum spray application rate must be reduced by entering the sampled Total Nitrogen value into Item 10 of the Nitrogen Balance Sheets for the appropriate month(s), and using the 'Update All Calculations' button on the Overview tab.

The Nitrogen Balance sheets also include calculations for the maximum allowable volume in Million Gallons per Month for each Field (Item 13 of the Nitrogen Balance Sheets). This is a reference value only,

as it assumes all available area is currently in use and fully utilized. If individual zones or pivots are partially or completely out of service, the actual maximum volume will be lower. Therefore, operators shall calculate inches per week and inches per hour for each reporting region based on the actual volume sprayed and the current active area using the following formula. Unless otherwise sepecified by DNREC, inches per week shall be calculated as a rolling 7 day average. The volume sprayed to each center pivot is determined by an individual flow meter, and the volume sprayed to the solid set zones is collectively calculated as the total pump flow minus the flow to each pivot.

$$Actual\ Hydraulic\ Application\ Rate\ \left(\frac{in}{week}\ or\ \frac{in}{hour}\right) = \frac{Volume\ Sprayed\ (\frac{MG}{week}\ or\ \frac{MG}{hour})}{Active\ Area\ (acres)} \times 36.83\left(\frac{acre-in}{MG}\right)$$

The most recent version of the DNREC Annual Report spreadsheet can be obtained from DNREC. The Annual Report spreadsheet is used for compliance monitoring based on actual spray volumes and concentrations, as well as other parameters. While this is a tool to assist in the required Annual Report, it will be filled out on a monthly basis so that trends can be observed and progress toward annual limitations can be tracked throughout the year.

2.9.2 Wastewater Loading Rate (inches/week)

§6.7.2.2.3.2.10.2.1.1

When nitrogen is not the limiting factor, the regulatory maximum loading is 2.5 inches per week. Based on the currently approved groundwater mounding models, wastewater application rates may not exceed a maximum of 1.65 inches/acre/7 day period absent DNREC written authorization. This limit may be increased in future permits if supported by updated groundwater mounding modeling and approved by DNREC. This limit has been incorporated into the Nitrogen Balance Spreadsheets, so the methodology in Section 2.9.1 accounts for these limitations.

2.9.3 Wastewater Application Rate (inches/hour)

§6.7.2.2.3.2.10.2.1.2

Based on the permeability studies performed by Brickhouse Environmental and included in the Design Development Report, the limiting soils permeability rate is 3.0 inches/acre/hour. The design infiltration rate is 10% of this value, which equals 0.3 inches/acre/hour. Wastewater application may not exceed this design rate, or more restrictive rate if established by the current Operating Permit. There will be a minimum rest period of one hour between applications on each section of the spray field.

2.9.4 Spray Field Application Cycles

§6.7.2.2.3.2.10.2.1.3

Applications will be timed whenever possible to times of greatest crop needs and limited in the winter and times of poor soil and weather conditions. For Phase 1, the amount of disposal area available greatly exceeds the minimum required area based on the Design Development Report calculations. This provides substantial flexibility in operations. The operators will utilize as much storage capacity as possible during the winter months and periods of inclement weather (saturated/frozen ground) and/or low crop moisture demands. Treatment processes should maximize nitrogen removal in treatment processes when not beneficial to crops. Operators will spread wastewater application across all available land in a manner that best utilizes nutrients and supplied moisture to enhance crop growth. Coordination between the

operators of the plant and the farming operations along with nutrient management planners concerning wastewater application frequencies, timing, and amounts are encouraged to maximize the agronomic benefits while minimizing any negative environmental impacts (runoff, drift, etc.).

2.9.5 Constituent Loading

§6.7.2.2.3.2.10.2.1.4

Table 2-3: Organics, Metals, Nitrogen and Phosphorus Loading

Constituent	Max Annual Loading	Units
Organics (as BOD_5)	N/A	
Nitrogen	See Operations Permit	
Phosphorus	31.2	lbs/acre
Lead	0.029	lbs/acre
Zinc	1.149	lbs/acre
Copper	0.212	lbs/acre
Nickel	0.218	lbs/acre
Cadmium	0.015	lbs/acre

1. The design BOD_5 concentration is 10 mg/L. There is no specific annual limitation established.
2. Nitrogen limitations are determined month-by-month accounting for the crop type, fertilizer application, and other factors. See Section 2.9.1.
3. Max Annual Loading for metals based on design assumptions. Higher loadings may decrease the overall site life based on the buildup of metals in the soil. The land-limiting constituent will be re-evaluated at each operations permit renewal.

2.9.6 Buffer Zones

Operators will familiarize themselves with the buffer zones indicated on the construction plans and permit documents, and ensure that spray irrigation is not applied on these areas. See Appendix G.1.

2.10 Spray Irrigation System Operation and Maintenance

§6.7.2.2.3.2.10.2.2

A sample O&M schedule for the disposal system is provided in Table 2-4. This can be adjusted as needed by the Manager of Wastewater Operations.

In the event of a leak or rupture in the piping system, the operator will be required to manually shut isolation valves affecting the pipe section and make repairs. If the isolation of the pipe segment is not possible, the irrigation pumps will be shut down and repairs made immediately.

2.10.1 Storage Ponds

§6.7.2.2.3.2.10.2.2.1

The storage ponds have been designed to require minimal maintenance. The monitoring wells around the lagoon will be regularly monitored and results tracked to determine if there are any issues with the liner. The lagoon aerators will be maintained in accordance with the manufacturer's recommendations. See Table 2-4 and Appendix F.1.

2.10.2 Irrigation Pump Station(s)

§6.7.2.2.3.2.10.2.2.2

The pump station will be manned daily so any problems which arise can be addressed immediately by personnel on-site. The pumps themselves as well as ancillary equipment such as valves and meters will be maintained in accordance with the manufacturer's recommendations. See Table 2-4 and Appendix F.2.

2.10.3 Spray Field Force Mains and Laterals

§6.7.2.2.3.2.10.2.2.3

Piping is located entirely within private lands or easements. Road crossings are all sleeved to allow access from either side. Pressure in the lines will be monitored. If any leaks are found, they will be repaired by AWMI in-house repair crews who are on call at all times.

2.10.4 Irrigation Equipment

§6.7.2.2.3.2.10.2.2.4

All irrigation equipment will be regularly inspected by AWMI staff as shown in Table 2-4. Spray heads or nozzles found to not be functioning will be repaired or replaced as needed. See Table 2-4 and Appendices F.3 and F.4.

Solid Set Clogged Nozzles:

- Manually remove blockage if visible.
- Replace clogged nozzles.
- Maintain an irrigation schedule so all nozzles receive periodic flushing.

Center Pivot Tracking Problems:

- Ensure tire pressure is set according to the O&M manual (See Appendix F.3, Reinke Center Pivot Manual, pg. 56).
- Ensure overwatering is not occurring.
- Apply material for improved traction in problem areas.

Table 2-4: Sample Disposal System Operation and Maintenance Schedule

O&M Activity	Frequency						
	Daily	Weekly	Monthly	3 mos.	6 mos.	Yearly	As Needed
Storage Pond(s)							
Note weather	X						
Note lagoon depth	X						
Routine yard maintenance			X				
Mowing of lagoon embankments							X
Removal of weeds and floatable debris							X
Any buildup of scum on pond surface							X
Signs of burrowing animals		X					
Algae buildup							X
Water-grown weeds							X
Evidence of dike erosion		X					
Evidence of berm leakage		X					
Check aerator operation	X						

Fence damage		X					
Aerator Amp Check			X				
Visually check aerator guiderails			X				
Check aerator motor condensate drains					X		
Check aerator wiring, restraints, cables, and floats					X		
Routine aerator motor lubrication					X		
Buffer zone maintenance							X
Irrigation Pump Station(s)							
Check pump operation	X						
Log running times and ensure pumps alternate properly	X						
Check chlorination feed rate	X						
Check wet well for debris and grease		X					
Check noise level		X					
Record operating ampere reading and check trends			X				
Verify flow meter accuracy						X	
Oil Inspection for SIP pump motors, and evidence of moisture or oxidation			X				
Grease inspection for SIP pump motors and evidence of moisture or oxidation			X				
Check SIP packing for overheating or excess flow			X				
Check vacuum release valve					X		
Check pressure release valve					X		
Check open weight & lever check valves					X		
Exercise isolation gate valves					X		
Spray Field Force Mains and Laterals							
Exercise isolation valves						X	
Check air release valves						X	
Check for leaks	X						
Irrigation Equipment							
Check disposal areas for frozen soil	X						
Check disposal areas for ponding or runoff	X						
Check spray rigs for wheel ruts		X					
Update nitrogen balance calculations		X					
Update spray field volume calculations		X					
Compare pumped vs. sprayed volumes to identify potential leaks		X					
Check center pivot motor starters (infrared thermography for hot spots)				X			
Verify pivot system electrical ground				X			
Inspect pivot for structural and electrical hazards				X			
Grease pivot bearing				X			

Check pivot gear boxes (center drive and wheel) for condensation and fill oil to proper level				X			
Check pivot wheel lugs and tire pressure				X			
Check pivot drive train components				X			
Check pivot alignment system				X			
Check pivot above ground pivot piping (flow meters, boots, clamps, and gaskets)				X			
Remove pivot sand traps				X			
Inspect all pivot sprinkler components				X			
Inspect solid set nozzles				X			
Inspect solid set zone valves				X			
Inspect solid set above ground piping				X			

1) This table is preliminary and may be adjusted as needed by the Manager of Wastewater Operations.

2.11 Vegetation Management

§6.7.2.2.3.2.10.2.3

A Vegetative & Nutrient Management Plan was developed as part of the Design Development Report and can be found in Appendix B. Both the cover crop and harvested crops will be established, monitored, maintained, cultivated, and harvested by the crop farmer according to standard farming practices. Operators will coordinate with the farmer to adjust irrigation schedules and fertilizer application as needed to optimize plant growth and ensure nitrogen balance criteria and other permit limitations are maintained.

A monthly total of the nitrogen applied to each field as fertilizer will be obtained from the farmer, as well as the type and amount of crop removed from each field, to be used in calculating the overall nitrogen balance for the annual report.

Buffer zones in the spray fields will be vegetated by the crops in use on that field, following typical farming practices. Buffer zones on the ANSRWRF site shall be maintained as follows:

Seasonal Mowing: Buffer zone mowing should be performed routinely, as needed, throughout the growing season. Grass height should not exceed 18 inches.

Inspection: Inspect buffer zones at least twice annually for erosion or damage to vegetation. The buffer zones should be checked for uniformity of vegetative cover, as well as for debris and litter. Bare spots should be replanted as needed. Vegetation may require irrigation immediately after planting, and during particularly dry periods, particularly as the vegetation is initially established.

Debris and Litter Removal: Trash tends to accumulate in vegetated areas, particularly along highways. Debris and litter should be removed for aesthetic reasons.

3 - Monitoring Program

Anticipated permit conditions are included in this O&M Manual. All monitoring is to be performed in compliance with the current operations permit requirements.

3.1 Influent and Effluent Monitoring

§6.7.2.2.4.1.1

3.1.1 Influent Monitoring

During Phase 1, the ANSRWRF site is not accepting raw wastewater. The influent flow to ANSRWRF is the effluent of the Allen Harim treatment process, and will be monitored at the metering and monitoring building on the Allen Harim site. See the Allen Harim O&M Manual and Operations Permit for details.

3.1.2 Effluent Monitoring

While the typical location for spray irrigation effluent standards is after treatment and prior to storage **(§6.3.2.3.2.2**), which for Phase I is the influent monitoring performed at the Allen Harim site, DNREC has assigned the ANSRWRF compliance monitoring point for Total Nitrogen, Fecal Coliform, and Metals to be at the ANSRWRF lagoon effluent pump station. Effluent sampling will include the parameters and frequency in Table 3-1 unless otherwise required by DNREC. See Section 2.9.1 for the use of Total Nitrogen in determining monthly application rates.

Additionally, AWMI will use a triggered approach to more closely monitor the effluent sent to the spray fields on an as-needed basis. See Section 3.5.2.2 for additional information.

Table 3-1: Effluent Monitoring

Parameter	Unit	Frequency	Sample Type
Fecal Coliform	col/100 ml	Monthly	Grab
Total Nitrogen	mg/L	Monthly	Grab
Cadmium	mg/L	Annually	Grab
Nickel	mg/L	Annually	Grab
Lead	mg/L	Annually	Grab
Zinc	mg/L	Annually	Grab
Copper	mg/L	Annually	Grab

3.2 Disposal System

3.2.1 Groundwater Monitoring

§6.7.2.2.4.1.2.1

3.2.1.1 Overview

Groundwater monitoring for the active spray sites will be conducted on a quarterly basis unless otherwise required by DNREC. This is necessary in order to evaluate increased levels of potentially mobile pollutants, as well as monitor groundwater fluctuation. All wells have been cased to prevent contamination from surface water.

Samples taken in compliance with the monitoring requirements specified in Table 3-2 will be taken at each monitoring well and observation well in accordance with procedures approved by the Department and listed in the State of Delaware Field Manual for Groundwater Sampling (Custer, 1988).

Specific conductance, pH, temperature, and dissolved oxygen will be measured using a calibrated field meter during well purging, which will be performed using either a submersible or peristaltic pump. Once the field parameters have stabilized, a groundwater sample will be obtained for the parameters listed as "Grab" in Table 3-2 and analyzed by a certified laboratory.

3.2.1.2 Pressure Transducer

At least one (1) monitoring well within the disposal area will be maintained with a pressure transducer to record water levels in accordance with **§6.8.1.10**. Pressure transducer readings will, at a minimum, be recorded at a one (1) hour frequency. These readings will be maintained and made available to the Department upon request.

3.2.1.3 Piezometers

Observation wells (piezometers) will be installed to measure seasonal high-water levels. Each observation well will be include a screen set across the water table. A float and dowel system will be installed in each observation well to float on the water table. The dowel will be inserted through the well cap into the float. The dowel will then be color coded to indicate depth to water (DTW) with green being DTW greater than 3 feet below grade, yellow being DTW from 3 to 2 feet below grade, and red being depth to water less than 2 feet.

While performing the monitoring described in Table 3-2, if the Depth to Water Table in any one of the monitoring wells has reached within 3 feet of the ground surface, the observation wells on the field in question will be observed weekly if spray is being conducted. The operators will discontinue spraying to the areas adjacent to the observation well if DTW reaches 2 feet (red coded), and the Ground Water Discharge Section will be notified within 24 hours. The spray fields will be restarted only after the DTW is greater than 2 feet (yellow coded). Weekly sampling may be discontinued when the DTW for all observation wells in the field in question are greater than 3 feet (green coded).

Table 3-2: Groundwater Monitoring

Parameter	Unit	Frequency	Sample Type
pH	S.U.	Quarterly	Field Test
Temperature	◦F	Quarterly	Field Test
Specific Conductance	µS/cm	Quarterly	Field Test
Dissolved Oxygen	mg/L	Quarterly	Field Test
Depth to Water Table	Hundredths of a foot	Quarterly	Field Test
Ammonia Nitrogen	mg/L	Quarterly	Grab
Nitrate + Nitrate as Nitrogen	mg/L	Quarterly	Grab
Total Nitrogen	mg/L	Quarterly	Grab
Total Coliforms	col/100ml	Quarterly	Grab
Fecal Coliform	col/100ml	Quarterly	Grab
Total Phosphorus	mg/L	Quarterly	Grab
Sodium	mg/L	Quarterly	Grab
Chloride	mg/L	Quarterly	Grab
Total Dissolved Solids	mg/L	Quarterly	Grab

Table 3-3: Monitoring Well Information

DNREC Well ID	Local ID	Northings (meters)	Eastings (meters)	Ground Elevations (ft)	Top of Outer Casing (ft)	Length of Stick Up (ft)	Casing Depth (ft)
254881	MW-1L	88993.83	206492.46	34.11	36.67	2.56	20
254882	MW-2L	89332.77	206846.20	33.21	35.67	2.46	20
254883	MW-3L	89038.74	207010.94	28.50	30.69	2.19	20
254884	MW-4L	88740.91	207018.88	34.11	36.67	2.56	20
258642	MW-1D	90060.87	206418.24	31.12	33.82	2.7	20
Pending	MW-2D	90482.14	206807.82	19.56	22.41	2.45	20
258645	MW-3D	90120.82	207104.73	25.28	27.73	2.45	20
258643	MW-4D	90198.79	206648.62	23.73	26.00	2.27	20
258637	MW-1E	89421.11	205657.01	32.54	35.00	2.46	20
258638	MW-2E	89900.00	205797.44	31.75	34.45	2.7	20
258639	MW-3E	90077.75	205986.56	22.79	25.45	2.66	20
258640	MW-4E	90077.30	206330.72	31.67	34.35	2.68	20
258641	MW-5E	89762.90	205979.61	31.83	34.54	2.71	20
258634	MW-1F	89056.08	206855.40	31.57	33.98	2.41	20
258632	MW-2F	89805.84	206844.26	31.53	33.93	2.4	20
258633	MW-3F	89653.61	207373.30	23.43	29.03	5.6	20
258635	MW-4F	88664.02	207398.01	18.48	20.98	2.5	20
258636	MW-5F	88901.57	207213.08	27.06	29.55	2.49	20
258620	MW-1G	87908.08	204453.82	39.08	41.88	2.8	20
258628	MW-2G	86961.64	204305.92	42.18	44.70	2.52	20
258630	MW-3G	87059.37	204894.01	38.48	40.82	2.34	20
258631	MW-4G	87083.99	205047.96	39.13	41.72	2.59	20
258625	MW-5G	87224.43	205871.48	35.28	38.11	2.83	20
258626	MW-6G	87338.98	206580.77	32.14	34.70	2.56	20
258627	MW-7G	87898.99	206585.64	33.23	35.64	2.41	20
258629	MW-8G	88466.82	206507.64	28.26	30.94	2.68	20
258624	MW-9G	87639.24	206170.14	33.67	36.15	2.48	20

1) Coordinates are in NAD 1983 Delaware State Plane 0700 Meters.
2) Monitoring Wells have been screened from a depth of 20 ft to 30 ft.
3) Monitoring Well MW-2D is installed, still pending a DNREC ID.

Table 3-4: Piezometer Information

DNREC Well ID	Local ID	Northings (meters)	Eastings (meters)	Ground Elevations (ft)	Top of Outer Casing (ft)	Length of Stick Up (ft)
Pending	PZ-1D	90411.76	206499.98			
Pending	PZ-2D	90421.83	207092.89			
Pending	PZ-1E	90040.15	206070.22			
Pending	PZ-2E	89890.51	205867.75			
265831	PZ-1F	88751.53	207166.42	22.53	25.53	25.41
265838	PZ-1G	87347.73	205271.49	35.45	38.86	37.92
265837	PZ-2G	87578.95	205093.80	37.31	41.29	40.00
265832	PZ-3G	87823.90	205250.09	32.78	43.00	41.81
265836	PZ-4G	87908.92	205455.69	32.64	36.24	32.23
265829	PZ-5G	88039.85	205768.25	32.67	35.97	35.23
265833	PZ-6G	88434.07	205949.66	31.58	34.63	33.21
265830	PZ-7G	88408.29	206450.31	25.91	29.58	29.92

1) Coordinates are in NAD 1983 Delaware State Plane 0700 Meters.
2) PZ-2E has been renamed, as the DDR had two piezometers named PZ-1E.
3) Coordinates on Fields D and E are approximate, and will be updated by the Manager of Wastewater Operations along with the DNREC Well IDs once surveying is complete and prior to the commencement of spray operations.

3.2.2 Surface Water

§6.7.2.2.4.1.2.2

Surface water monitoring requirements are to be conducted quarterly at the surface water locations identified in Appendix G.1. Surface water sampling should not occur within 3 days of a measurable rainfall event. This delay will help insure that the streams have returned to base flow, i.e. groundwater dominant, conditions. Samples at all locations should be taken on the same day, with down gradient samples for each surface water body taken immediately followed by the upstream locations.

Table 3-5: Surface Water Monitoring

Parameter	Unit	Frequency	Sample Type
Ammonia as Nitrogen	mg/L	Quarterly	Grab
BOD_5	mg/L	Quarterly	Grab
Chloride	mg/L	Quarterly	Grab
Dissolved Oxygen	mg/L	Quarterly	Field Test
Enterococcus	Col/ 100mL	Quarterly	Grab
Fecal Coliform	Col/100mL	Quarterly	Grab
Nitrate + Nitrite as Nitrogen	mg/L	Quarterly	Grab
pH	S.U.	Quarterly	Field Test
Sodium	mg/L	Quarterly	Grab
Specific Conductance	µS/cm	Quarterly	Field Test
Temperature	◦C	Quarterly	Field Test
Total Dissolved Solids	mg/L	Quarterly	Grab
Total Suspended Solids	mg/L	Quarterly	Grab
Total Nitrogen	mg/L	Quarterly	Grab
Total Phosphorus	mg/L	Quarterly	Grab

Table 3-6: Surface Water Monitoring Location Information

Local ID	Northings	Eastings
SW-1	88368.84	205871.47
SW-2	88557.43	206493.46
SW-3	88638.01	207393.63
SW-4	90245.11	205198.77
SW-5	90372.08	206230.09
SW-6	90363.90	207758.40

1) Coordinates are in NAD 1983 Delaware State Plane 0700 Meters.

3.2.3 Storage Ponds

§6.7.2.2.4.1.2.3

Storage lagoon operational monitoring will be conducted on a weekly basis and will be maintained in the operators log book. These records are solely for the use of the operator to ensure the maintenance of the lagoon.

Table 3-7: Storage Lagoon Monitoring

Parameter	Unit	Unit	Sample Type
Dissolved Oxygen	mg/L	Weekly	In-situ
Lagoon Level	Feet	Weekly	In-situ
pH	S.U.	Weekly	In-situ
Temperature	◦C	Weekly	In-situ

3.2.4 Lysimeters

§6.7.2.2.4.1.2.4

Lysimeters will be installed to help verify percolate nitrogen concentrations. One lysimeter will be installed on each of the spray sites. For sites with proposed wooded and open wetted field areas, one lysimeter is proposed in the wooded area and one in the open area. Lysimeter sampling will be performed in accordance with the DNREC General Lysimeter Construction and Sampling Guidelines, published January 2014.

Lysimeter sampling will include the parameters in Table 3-8 unless otherwise required by DNREC. The constituents are listed below in highest priority. In the event that enough sample volume is not obtained to test for all parameters listed, the sample will be tested for as many constituents as possible.

Table 3-8: Lysimeter Monitoring

Parameter	Unit	Frequency	Sample Type
Total Nitrogen	mg/L	Monthly	Grab
Total Phosphorus	mg/L	Monthly	Grab
Nitrate + Nitrate as Nitrogen	mg/L	Monthly	Grab
Ammonia as Nitrogen	mg/L	Monthly	Grab
Chloride	mg/L	Monthly	Grab
Sodium	mg/L	Monthly	Grab
Total Dissolved Solids	mg/L	Monthly	Grab
pH	S.U.	Monthly	Field Test
Specific Conductance	µS/cm	Monthly	Field Test
Temperature	◦F	Monthly	Field Test

Table 3-9: Lysimeter Information

DNREC Well ID	Local ID	Northings (meters)	Eastings (meters)	Ground Elevation (ft)	Outer Casing (ft)	Inner Casing (ft)
Pending	LY-1D	90202.98	206753.94			
Pending	LY-1E	89694.85	206156.54			
Pending	LY-2E	89927.50	205798.69			
265827	LY-1F	89388.92	207110.93	33.13	35.73	35.23
265835	LY-1G	87984.44	205584.58	34.27	36.22	35.38
265834	LY-2G	87646.77	206139.14	33.80	36.10	35.82
265828	LY-3G	87205.37	204810.20	40.62	43.25	42.82

1) Coordinates are in NAD 1983 Delaware State Plane 0700 Meters.
2) Coordinates on Fields D and E are approximate, and will be updated by the Manager of Wastewater Operations along with the DNREC Well IDs once surveying is complete and prior to the commencement of spray operations.

3.3 Soil Sampling and Testing

§6.7.2.2.4.2

Soils will be sampled according to Table 3-10 unless otherwise required by DNREC. Soil sampling shall be performed in accordance with **§6.2.2.3** and **§6.2.2.3.1**. One composite sample will be taken for every 50 acres of each soil series unless otherwise indicated by DNREC. As part of the Five Year Compliance Monitoring Report described in **§6.5.4**, spray irrigation fields will be assessed every five years to determine if soils renovation or maintenance is necessary. These assessments will include a review of the annual soil samples. Assessments will address crop consistency, soil monitoring results, infiltration, and compaction.

Table 3-10: Soils Monitoring

Parameter	Unit	Frequency	Sample Type
pH	S.U.	Annually	Soil Composite
Organic Matter	%	Annually	Soil Composite
Phosphorus (as P_2O_5)	mg/kg	Annually	Soil Composite
Potassium	mg/kg	Annually	Soil Composite
Sodium Adsorption Ratio	meq/ 100 g	Annually	Soil Composite
Cadmium	mg/kg	Once per 5 years	Soil Composite
Nickel	mg/kg	Once per 5 years	Soil Composite
Lead	mg/kg	Once per 5 years	Soil Composite
Zinc	mg/kg	Once per 5 years	Soil Composite
Copper	mg/kg	Once per 5 years	Soil Composite
Cation Exchange Capacity	meq/ 100 g	* if soil pH changes significantly	Soil Composite
Phosphorus Adsorption	meq/ 100 g	*if phosphorus levels become excessive (see **§6.8.3.1**)	Soil Composite
Percent Base Saturation	%	*if soil pH changes significantly	Soil Composite

3.4 Ambient Conditions Monitoring

§6.7.2.2.4.3

Operators will log precipitation and wind speed based on nearby meteorological stations or on-site observations. Additionally, operators will log whether spray irrigation was suspended due to saturated or frozen soil conditions, wind speed, or other ambient conditions.

3.5 Interpretation of Monitoring Results

§6.7.2.2.4.4

3.5.1 Treatment System

For Phase 1, the treatment will be performed by Allen Harim, under a separate operations permit. Monitoring results from the effluent of the treatment process will be collected by Allen Harim operators who are appropriately licensed by DNREC, analyzed by labs appropriately certified by the EPA, and reviewed by both Allen Harim and AWMI wastewater staff for compliance with service agreements and permit conditions. O&M adjustments at these facilities, including system upgrades as needed, will be performed in accordance with service agreements and permit conditions.

3.5.2 Disposal System

For Phase 1, the transition point between treatment by Allen Harim and disposal by AWMI will be at the metering and monitoring building on Allen Harim's Harbeson site. Effluent quantity and quality will be monitored to ensure that the conditions of both the Allen Harim and AWMI operating permits are maintained. See the Allen Harim O&M Manual and Operations Permit for additional information. In order for both parties to ensure compliance of their permit conditions, the following provisions will be in place:

1. Grab Samples:
    a. Allen Harim will be responsible for taking samples of the treated effluent at the metering and monitoring building in the frequency determined by their treatment operations permit. All lab samples results will be directly sent by the lab to both Allen Harim and AWMI.
    b. Upon contacting Allen Harim, AWMI may go on-site to the Allen Harim metering and monitoring building to take supplemental samples at its discretion. In an emergency, AWMI may enter immediately after checking in at the guard house to perform these samples. Otherwise, 24 hours written notice must be provided. Allen Harim may have a representative present and request split samples if desired.
2. Continuous Sensors:
    a. Continuous monitoring sensors will monitor for flow rate, pH, turbidity, oxidation/reduction potential, and chlorine residual. These continuous results will be data logged and visible for remote viewing in the SCADA systems of both Allen Harim and AWMI.
        i. The continuous monitoring of flow is required by **§6.8.2.3**.
        ii. The continuous monitoring of turbidity is required by **§6.3.2.3.3.2.5**.
        iii. The continuous monitoring of chlorine is required by **§6.3.2.3.3.2.3.2**.
        iv. The continuous monitoring of pH and oxidation/reduction potential are not required by regulation, and are provided as a supplemental source of information to aid Allen Harim operators. These are not intended for direct permit compliance but have been incorporated into the design as a further operational tool.
3. AWMI operators will review both regular and supplemental sample results for compliance with Allen Harim's permit conditions and service agreement with AWMI. In addition to identifying non-complying wastewater results, operators will note trends or spikes which may indicate a risk of future non-compliance. Upon identifying such trends or non-compliant results, AWMI operators will contact Allen Harim operators to alert them of the concern and coordinate any necessary corrective measures, O&M adjustments, and/or system upgrades.

3.5.2.1 Corrective Measures

Conditions under which Allen Harim will be required to divert flow due to non-compliance are described in the Allen Harim O&M Manual and Operations Permit. Note that the AWMI disposal system is designed with a large degree of flexibility in various forms, and is therefore able to maintain disposal permit compliance even in the event of moderate amounts of non-conforming wastewater entering the lagoon.

This flexibility includes the availability of excess disposal area which allows the disposal nitrogen requirements to be met even with elevated influent nitrogen concentrations.

In the event that Allen Harim diverts flow due to non-compliance, AWMI will temporarily cease spray operations and commence Lagoon Testing Procedures (see Section 3.5.2.2).

3.5.2.2 Lagoon Testing Procedures

As described in Section 3.1.2, AWMI will take monthly samples of Total Nitrogen and Fecal Coliforms, and annual metals samples at the lagoon effluent pumps. If a monthly sample is above the AWMI Operations Permit level, AWMI will commence Lagoon Testing Procedures described below. The metals values will be used in site life calculations.

Additionally, AWMI will use a triggered approach to more closely monitor the effluent sent to the spray fields on an as-needed basis. Elevated concentrations of parameters of concern entering the AWMI storage lagoon will tend to be diluted by existing compliant water. Depending on the particular situation, this dilution may reduce the concentrations to within compliance. Furthermore, elevated concentrations will take time to mix throughout the lagoon and reach the effluent pumps. Therefore, if non-compliant effluent as defined in the Allen Harim Operations Permit enters the lagoon, additional sampling will be conducted at the lagoon to track the extent of the issue and to determine when spray operations may be conducted. At their discretion, operators may also initiate Lagoon Testing Procedures for reasons other than non-compliant Allen Harim effluent.

Lagoon Testing Procedures Action Steps:

1. While Lagoon Testing Procedures are in effect, AWMI shall be troubleshooting and using available contingency methods, including those discussed in Section 5.2, to maximize the time until effluent at the spray pump sample tap is out of compliance and minimize the time that any portion of the lagoon contains non-compliant water.
2. If a review of Allen Harim and AWMI Operations data indicates that the exceedances at Allen Harim triggering the Lagoon Testing were minor and unlikely to have substantially impacted concentrations within the lagoon near the pump station, spray irrigation may be resumed while the Lagoon Testing samples are being analyzed. Otherwise, spray irrigation shall remain suspended until sample results are returned.
3. AWMI will take weekly grab samples at three locations:
    a. Within the lagoon at the inlet, approximately 3 feet below the surface.
    b. Within the lagoon halfway between the inlet and outlet, approximately 3 feet below the surface.
    c. At the spray pump sample tap (or the effluent pump wet well if pumps are off).
4. If spray pump sample tap and lagoon samples are compliant with the AWMI discharge permit:
    a. Resume or continue spray operations.
    b. Continue resampling at a frequency of weekly grab samples.
5. If lagoon samples are non-compliant but spray pump sample tap samples are compliant with the AWMI discharge permit:
    a. Operators shall use best professional judgement on whether to suspend or continue spray operations. Consideration shall include whether the specific scenario involves a rapid spread or a slow spread of non-compliance from the lagoon inlet to the lagoon halfway

point, and the expected duration that the effluent at the spray pumps will remain in compliance.

b. AWMI increases the sample frequency at the three locations (lagoon inlet, lagoon midpoint, spray pump sample tap) from weekly to daily grab samples.

6. If the spray pump sample tap sample is out of compliance with the AWMI discharge permit:
    a. AWMI suspends spray operations.
        i. Spray operations may not resume until an action plan is approved by DNREC.
        ii. If Total Nitrogen is above the permit level, see Section 2.9.1 for how to calculate a revised application rate to maintain compliance with the PSN2 requirements. This revised rate should be included in the action plan.
    b. AWMI increases the sample frequency at the three lagoon locations (lagoon inlet, lagoon midpoint, spray pump sample tap) from weekly to daily grab samples.
    c. AWMI troubleshoots and works to bring the lagoon back into compliance.
    d. If any parameter at the Allen Harim site is above the Action Threshold, Allen Harim immediately diverts flow to on-site storage lagoon.
        i. Flow may not resume to AWMI until an action plan is approved by Allen Harim and AWMI.
    e. However, if Allen Harim flow is compliant, this volume is beneficial to diluting the non-compliant water within the lagoon and may continue.
7. Lagoon Testing Procedures may be concluded when the influent from Allen Harim is compliant according to the Allen Harim Operations Permit, and three consecutive samples of the three ANSRWRF lagoon sample locations (lagoon inlet, lagoon midpoint, spray pump sample tap) are within compliance of the AWMI discharge permit.

3.5.3 Groundwater

Groundwater monitoring results at the ANSRWRF facility will be collected from permitted monitoring wells by AWMI operators who are appropriately licensed by DNREC, analyzed by labs appropriately certified by the EPA, and reviewed by AWMI wastewater staff for compliance with state and federal laws and permit conditions. O&M adjustments, including system upgrades, will be made as necessary.

Operators will review the groundwater sample results on a quarterly basis and look for trends or spikes in any parameter, with particular attention paid to nitrate levels. If upward trends or spikes are noted in any parameter, this will be further investigated to determine whether operational or equipment adjustments are required to maintain permit compliance.

When applying for operations permit re-issuance, a hydrogeological report will be signed and sealed by a professional geologist in accordance with **§6.5.4.3.2**. This report will include interpretations of groundwater levels, characteristics, and trends, and provide recommendations for future monitoring, system upgrades, and O&M adjustments.

3.5.4 Soils

Soil borings results at the ANSRWRF facility will be collected from each spray field by licensed samplers, analyzed by EPA approved labs and reviewed by AWMI wastewater staff for compliance with state and federal laws and permit conditions. Field application adjustments, if any, will be made as necessary.

When applying for operations permit re-issuance, a soil report will be signed and sealed by a Class D.3 soil scientist in accordance with **§6.5.4.3.1.1**. This report will include interpretations of soil results and land limiting constituents, and provide recommendations for future monitoring, system upgrades, and O&M adjustments.

4 - Records and Reports

4.1 Records

4.1.1 Record Keeping

All reports will be kept for five years. These records include: worksheets used in determining information provided on the report forms plus any records of raw data; calibration and maintenance records; quality assurance records provided by the operations department on all equipment and chemicals; DNREC reports; and flow charts. This period of retention shall be extended automatically during the course of any unresolved litigation regarded the regulated activity or regarding control standards applicable to the permittee or as requested by the Department.

4.1.2 Maintenance Records

§6.7.2.2.5.1

Both preventative and corrective maintenance activities will be recorded in the operator log.

4.1.3 Operating Records

A daily record will be maintained by the operator in a bound book and kept on site at all-time. The following, at a minimum, will be included in the log:

1. Time spent at the treatment facility on any date.
2. Details of the operation and maintenance performed on the treatment system and spray irrigation systems on any date including both preventative and corrective maintenance.
3. The volume of wastewater sprayed to each section of the disposal system on any date, the times the system runs on each area, and the acreage over which the wastewater was distributed.
4. Record and calculate influent and effluent totalizer flows daily.
5. Identification of those portions of the fields that are ponded on any date.
6. A record of any deviations from the operation and maintenance manual.
7. Daily weather conditions.
8. A record of all actions taken to correct any violations of the Environmental Protection Act and Departments Regulations.
9. A site map showing the disposal area with each center pivot or solid set spray zone numbered.
10. A record of all site management activities undertaken such as planting, reseeding, harvesting or crops, fertilizations, and etc.
11. Any miscellaneous items such as:
    a. Accidents to personnel
    b. Complaints
    c. Power consumption
    d. Plant visitors

Additional information that will be logged includes:

1. Log chemical tank levels and chemical feed rates daily.
2. Record equipment ETMs and check operations daily.

4.2 Reports

A summary of the required reports to DNREC is provided in this section. However, these requirements are subject to change, and the current operations permit will be consulted for specific requirements. Signed copies of all required reports will be submitted to the Department at:

Delaware Department of Natural Resources and Environmental Control
Ground Water Discharges Section
89 Kings Highway
Dover, DE 19901

4.2.1 Monthly Reports

§6.7.2.2.5.2

The monitoring requirements and instructions for monthly reporting are included in the operations permit. These requirements include flow volume and characteristics into the lagoon, volume applied to the disposal system, disposal system operation scheduling and loading rates, groundwater monitoring results, surface water monitoring results, soil sampling results, and rainfall and weather data. The results will be summarized for each month/quarter and reported to the Department on an approved Spray Effluent Monitoring Report Form. See also Section 3 for more details on the sampling requirements.

4.2.2 Annual Reports

Operators will submit to the Department an annual operation report each year. The annual operation report will summarize operational and maintenance activities at the facility along with management and administration of the facility and will include everything required by **§6.9**.

4.2.3 Compliance Monitoring Report (CMR)

Operators will submit a CMR every five years prior to the expiration date of the operation permit. This report will include a Soils Report, a Hydrogeologic Suitability Report, an Engineering Operation Report, a Vegetative Management Plan, a Biosolids Management Plan, and Conclusions/Recommendations as required by **§6.5.4**

4.2.4 Noncompliance Reporting

The permittee will report to the Department's Enforcement Section at 800-662-8802 any unpermitted release or discharge of any contaminant into the air, or a pollutant into surface waters, groundwater or onto land as soon as the permittee has knowledge of the release or discharges.

Within 24 hours of becoming aware of any actual or anticipated noncompliance which may endanger public health or the environment, the operator will make an oral report to the Department at 302-739-9948. The operator will also submit a written report of the noncompliance to DNREC within five days of becoming aware of any actual or potential noncompliance. The report will include the following:

1. A description of and cause for the noncompliance with any such limitation or condition.
2. The period of noncompliance, including exact date and time; or if not corrected, the anticipated time the noncompliance is expected to continue.
3. Steps being taken to reduce eliminate and or prevent recurrence of the noncompliance conditions.

5 - Emergency and Contingency Planning

§6.7.2.2.6

5.1 Emergency Operations and Response

5.1.1 Overview

Emergencies from the treatment plant and irrigation system can arise form waters, natural disasters, criminal action, and equipment malfunctions. The following items are made part of the Emergency Operating and Response Program.

If the operator sees or suspects any problems with the treatment plant or collection system which threaten the environment he/she will contact the following:

a. AWMI Supervisor
b. DNREC
c. Affected Residences

5.1.2 Emergency Telephone Number List

Table 5-1: Emergency Phone Numbers

Police	911
Fire	911
Emergency Services, Local	911
Hospital	911
DNREC Enforcement	800-662-8802
DNREC GWDS Dover Office	302-739-9948
Electric Service (Delaware Electric Coop)	855-332-9090
Chemical Supplier	
Direct Responsible Charge (DRC) Operator	
Back-Up Operator	
Spray Irrigation Farmer	
Contacts for Agricultural Land Irrigation	
Agland Preservation & Planning	302-698-4531
Nutrient Management	302-698-4558
Agriculture Compliance	302-698-4524

(This list should be kept up-to-date as needed by the Manager of Wastewater Operations.)

5.1.3 Document Management

It is important for the operator to maintain two (2) sets of files for all reports, drawings, O&M manuals and correspondence. One file will be kept off-site and the other at the treatment plant.

5.1.4 Alerts

An auto dialer will alert the operator of the following, as well as any additional warnings selected by the operators:

a. High lagoon level
b. Low pressure in the distribution force main
c. High pressure in the distribution force main
d. Loss of power

5.1.5 Emergency Aid

911 can provide emergency services.

5.1.6 Floods

The treatment plant and pump station are above the level expected for a hundred-year storm.

5.1.7 Fire

In the event of a fire, the operator will:

a. Analyze the problem and use fire extinguishers provided at the plant or contact the local fire department (911).
b. Evacuate the building immediately.

5.1.8 Windstorm

If a windstorm should strike the plant, the operator will assess the damage, and if damage is severe enough to cause noncompliance with permit conditions, the operator will inform DNREC of the nature and extent of damage. Steps will be taken immediately to return the plant back to full operations.

5.1.9 Explosions

The operator will contact the fire company immediately. Whatever has been damaged will be evaluated, and the system will be returned to service as quickly as possible.

5.1.10 Repair Priorities

In the event of a natural disaster or other emergency situation causing damage to infrastructure, the order of priorities for repair are as follows:

1. Structural integrity of lagoon.
2. Influent force main.
3. Effluent pump station to spray fields.
4. Center pivots, starting with the largest rigs.
5. Solid sets, starting with the largest zones.
6. Effluent force main to spray fields.
7. Supplemental chlorine.
8. Lagoon Aerators.

5.2 Operational Contingency Plan Guidelines

5.2.1 Contingency Operational Options

See Section 3.5 for a discussion of the protocols for monitoring and responding to non-compliant water.

The ANSRWRF facility has been designed with a range of available options to reduce, eliminate, and/or prevent non-compliant conditions, in accordance with **§6.3.2.3.13.7**. These options include the following items.

1. Standard operating procedure is to spray whenever weather, crop, soil, and land-limiting constituent conditions allow, so that the lagoon is kept to a minimum level at all times. This maximizes the available storage for addressing abnormal conditions such as excess precipitation or extended periods of subfreezing temperature.

2. The lagoon designed for Phase 1 includes approximately 23 million gallons of excess capacity intended for future increases in disposal volume. This excess capacity is available during Phase 1 to address any emergency conditions, and represents an extra 15 days of storage at Phase 1 flow rates. Utilizing this volume may require prior approval from DNREC including a plan for how to empty the excess volume in a timely fashion, likely by utilizing excess spray area on Fields D, E, and F. See Section 1.1.1 for a discussion of Fields D and E.
3. The lagoon design includes an additional 3 feet of freeboard in excess of the design volume, which represents additional storage that can be utilized in emergency conditions. This may require notification of DNREC and coordination of relief measures. See Table 1-1.
4. An additional bypass lagoon with at least 2 days of storage volume will be provided on-site by Allen Harim. In the event of a treatment upset at the Allen Harim WWTF leading to non-compliant wastewater, this wastewater will be diverted to a bypass lagoon so as not to contaminate the compliant effluent in the ANSRWRF storage lagoon. This non-compliant wastewater can be directed back to the head of the Allen Harim plant for retreatment. See the Allen Harim O&M Manual and Operations Permit for additional information.
5. In the unlikely event that some amount of effluent with concentrations exceeding a permit limit do arrive in the ANSRWRF lagoon, spray operations can be temporarily suspended. Additional monitoring will be performed at the lagoon, and if needed, additional chlorination or portable treatment used to bring effluent back to compliant condition prior to disposal. See Section 3.5 for additional information.
6. The Phase 1 construction permit includes more than the minimum required land for spray disposal. These additional fields are available to provide flexibility in operations. If challenging conditions arise, additional fields can be brought into operational use to address the issue.
7. If necessary, the operators may seek temporary permission to exceed the design spray limit of 1.65 inches per week, which is a permit condition based on groundwater models, rather than regulatory limits. Provided groundwater levels are not excessive and nitrogen balance calculations allow, there is flexibility to provide a 50% increase in spray rates when authorized by DNREC without exceeding the regulatory limit. DNREC also considers temporary waivers to the 2.5 inches per week limit in emergency situations.

5.2.2 Supplemental Loading Allowances

Operators with authorization from the DNREC Ground Water Discharges Section can allow irrigation at greater than 1.65 inches per week. This authorization can be provided at any time, not just during periods of excess storage. Prior to contacting DNREC, operators will check the depth to groundwater for the areas where additional spray authorization is requested and compare this to the minimum allowable depth of 2 feet.

5.2.3 Investigation of Pooling Actives

When, or if, pooling conditions occur that are associated with rainfall/irrigation application less than those described, these areas will be identified for further evaluation and corrective action. Corrective actions may involve soil conditioning to eliminate compaction, removal, and replacement of limited areas of non-conforming slowly permeable soils, re-grading of closed depressions that accumulate more than the design application rate due to movement of water from other areas, etc. The DNREC Ground Water Discharges Section will be notified to concur with path forward for any corrective actions sought.

In the event that any particular spray irrigation area is adversely impacted by an area of pooling that cannot be corrected by the methods indicated previously, then modifications to the spray irrigation system can be investigated that would avoid application to the pooled area but continue to allow the remainder of the spray irrigation area to be utilized.

5.3 Treatment Plant Safety

5.3.1 Discussion

In this section, the focus will center on the causes of accidents, the identification of unsafe working conditions and the need for individual facility safety programs to promote the status of safety of the treatment plant.

5.3.2 Safety Program

A plan of action for enlisting and maintaining the support of all personnel of an organization for the purpose of preventing accidents will be prepared. All personnel shall understand their roles and which lines of responsibility and authority are clearly defined.

The basic elements of a safety program are:

1. Management leadership
2. Assignment of responsibility
3. Maintenance of safe working conditions
4. Establishment of safety training
5. An accident record system
6. Medical and first aid systems
7. Acceptance of personal reasonability by employees
8. Tools and equipment

To carry on an effective safety program there will be: safety meetings, safety inspections, and safety training. The meetings will be held frequently. Safety inspections will be conducted regularly during normal working hours.

It is essential that the workers be trained in the principles of safety in safe work methods, and in emergency responses. Each employee will be trained in the basics of first aid, and each supervisor will receive additional training in advanced first aid techniques.

5.3.3 Hazards

The hazards that cause accidents in treatment plants may be classified as:

1. Physical injuries
2. Noxious gases
3. Health Hazards

5.3.4 Prevention of Physical Injuries

The major causes of physical injuries are slips and falls. Tools, parts and other items will not be left lying around. Grease, oil, and sludges will be cleaned up as soon as possible. Warning signs, railings and covers in place can protect against low piping, open hatches, and tanks.

1. Manholes

Manhole work requires full protective measures from traffic hazards as well as from hazards of explosive gases, hydrogen sulfide, or lack of oxygen. Manholes of sanitary systems are to be treated as confined spaces and entered according to OSHA regulations. When lifting a cover, a pick axe may slip or give off a spark. Use appropriate tools.

Before entering, the atmosphere will be tested for the presence of explosive gases, hydrogen sulfide, and oxygen deficiency. After determining the conditions are safe, positive forced air ventilation will be started and operated whenever anyone enters. There will also be a continuous sampling of the atmosphere with a visual signal alarm device kept near the worker.

The worker will also be in constant contact with a person on the surface utilizing explosion-proof radios.

Before entry, notes will be taken on the width, spacing, and arrangement of manhole rungs. Each rung will be tested during descent. A safer means would be to use a manhole ladder.

a. Safety Harness
   No one will enter a manhole without wearing a full-body harness with rope attached to a wench and tripod.
b. Lighting
   Explosion-proof lamps will be utilized.
c. Electrical Hazards
   Grounding of all equipment is necessary when work is done on equipment controlled by a switch located some distance away. The switch will be tagged and locked out. Portable power tools will be equipped with a ground wire and special outlet plug. The use of a rubber mat is a good idea. Do not work on any equipment that you have not been trained on.

5.3.5 Noxious Gases or Vapors, Explosive Gases and Oxygen Deficiency

1. General

Explosive gases such as natural gas may be present due to leaking gas mains or individual service connections. Oxygen deficiency and the presence of hydrogen sulfide are often companion occurrences. This is the result of the biological activity that takes place in a sewer system or in any confined space where wastewater has collected. Toxic gases which are poisonous to breath, such as hydrogen sulfide, can also be present.

2. Oxygen Deficiency and Hydrogen Sulfide

Air by volume normally contains 21% oxygen and 70% nitrogen and traces of other gases. An atmosphere containing less than 19.5% oxygen by volume is dangerous to humans. Oxygen deficiency and hydrogen sulfide gas appear to be the leading cause of death in sewers.

3. Explosive Range

Flammable or burnable gases, when mixed with air in certain proportions, will explode violently upon ignition. No explosion will occur when the mixture is outside this range. The minimum concentration of a gas air or vapor mixture which will explode if ignited is known as the explosive limit, while the maximum concentration for explosions is called the upper explosive limit. See Table 5-3.

4. Hazardous Locations

The places which are most likely to be dangerous from noxious gas, vapor saturation, or oxygen deficiency and which will be carefully investigated before entering are:

a. All sewers
b. Any tightly covered pit, tank, or valve chamber

5. Characteristics

For characteristics of noxious gas and vapors and their most likely source, see Table 5-3.

6. Detection

See Table 5-3 for detection practices.

7. Summary of Safe Practices in Sewers, Pumping Station Wet Wells, and Other Confined Areas
   a. Condition I. Tests show no hazardous situation to gases, vapors, or lack of oxygen. Personnel entering sewers or confined spaces will wear safety harnesses and be attached to a winch and tripod. At least one person must be available at the top. Even though tests show no hazards, the situation may change or the personnel may be injured. No one will smoke within the manhole and sparks will be prevented by the use of non-sparking, beryllium copper alloy tools. Safety shoes with good traction will be worn.

      Sampling the atmosphere will begin before entry and continued throughout the working period. Forced air ventilation will be started before entry and operated continuously.

   b. Condition II. Tests show noxious gases, vapors or oxygen deficiency. The structure will be thoroughly ventilated with extreme care taken to avoid ignition of flammable gas, and retested. No one will enter the confined space until the sampling indicates that the atmosphere is safe for entry. Forced air ventilation and sampling for air quality will be continuous throughout the work period. Access to the area will be as described in Condition I.

   c. Condition III. Tests show a hazardous situation, but an emergency exists which requires immediate entry. First, information about the emergency situation must be relayed to the home base prior to entry so that assistance can be provided. Second, the opening of the confined space cannot be left unattended. Third, anyone entering must be trained in confined space rescue and must be wearing appropriate respiratory apparatus.

5.3.6 Health Hazards

1. General

Wastewater facility workers are exposed to a variety of situations that may pose significant health hazards. The wastewater can be expected to contain whatever infections or parasitic disease is present in the service area.

2. First Aid

Except for minor injuries, wounds will be treated by a doctor and reported for possible workmen's compensations. Service trucks and the treatment plant will have first aid kits, and as many of the personnel will have Red Cross first aid instruction.

3. Wearing Apparel

Protective clothing including gloves, work clothes, and waterproof, steel-toed boots will be worn whenever appropriate. Clothing will be washed frequently and left at the work place in a locker separate

from street clothes. This will minimize the danger of bringing an infectious microorganism home from work.

5.3.7 Safety Hazards in Operation

1. Sewers

The presence of explosive gases, hydrogen sulfide, and the lack of oxygen are conditions that are immediately hazardous to personnel lifted. Through initial planning of each phase of the work is necessary to safely accomplish these assignments.

2. Personal Habits

A majority of infections reach the body by way of the mouth, nose, eyes, or ears. The personnel will always wash their hands before eating and smoking. Appropriate shots will be recommended.

3. Testing

The testing work place will be kept clean and orderly to reduce potential hazards. The operator will be familiar with the chemicals in use since some have explosive and corrosive characteristics. Biological hazards also exist, but can be averted if the operators protect themselves using good personal hygiene practices and protective clothing and gear. MSDS sheets are to be kept on-site and made readily available at all times and in cases of emergency.

4. Treatment Chemicals

All bulk treatment chemicals are labeled with directions for use and their potential harmful effects.

5.3.8 Safety Equipment

Table 5-2: Safety Equipment

Item	Location	Use
Fire Extinguisher		Fire
Life Preservers		Emergency Flotation
First Aid Kit		Minor cuts and injuries

(This list should be kept up-to-date as needed by the Manager of Wastewater Operations.)

Table 5-3: Common Dangerous Gases Encountered in Sewers and Sewage Treatment Plants[1]

Name of Gas	Chemical Formula	Specific Gravity or Vapor Density[2]	Explosive Range (% by Volume in air)		Common Properties (Percentages are percent in air by volume)	Physiological Effects (Percentages are percent in air by volume)	Most Common Sources in Sewers	Method of Testing[3]
Oxygen (In air)	O_2	1.11	Not Flammable		Colorless, odorless, tasteless, non-poisonous gas. Supports combustion.	Normal air contains 20.93% of O_2. Man tolerates down to 12%. Below 5 to 7% likely to be fatal.	Oxygen depletion from poor ventilation and absorption or chemical consumption of available oxygen.	Oxygen deficiency indicator.
Gasoline Vapor	C_5H_{12} to C_9H_{20}	3.0 to 4.0	1.3	7.0	Colorless. Odor noticeable at 0.03%. Flammable. Explosive.	Anesthetic effects when inhaled. Rapidly fatal at 2.43%. Dangerous for short exposure at 1.1 to 2.2%.	Leaking storage tanks, discharges from garages and commercial or home dry cleaning operations.	1. Combustible gas indicator. 2. Oxygen deficiency indicator for concentrations over 0.3%
Carbon Monoxide	CO	0.97	12.5	74.2	Colorless, odorless, tasteless, non-irritating, flammable. Poisonous.	Hemoglobin of blood has strong affinity for gas causing oxygen starvation. 0.2 to 0.25% causes unconsciousness in 30 min.	Manufactured fuel gas.	Carbon monoxide gas monitor
Hydrogen	H_2	0.07	4.0	74.2	Colorless, odorless, tasteless, non-poisonous, flammable. Explosive. Propagates flame rapidly; very dangerous.	Acts mechanically to deprive tissues of oxygen. Does not support life. A simple asphyxiant.	Manufactured fuel gas.	Combustible gas indicator.
Methane	CH_4	0.55	5.0	15.0	Colorless, odorless, tasteless, non-poisonous. Flammable. Explosive.	See Hydrogen.	Natural gas, marsh gas, mfg. fuel gas, sewer gas.	1. Combustible gas indicator. 2. Oxygen deficiency indicator.
Hydrogen Sulfide	H_2S	1.19	4.3	46.0	Rotten egg odor in small concentrations but sense of smell rapidly impaired. Odor not evident at high concentrations. Colorless. Flammable. Explosive. Poisonous.	Death in a few minutes at 0.2%. Paralyzes respiratory center.	Petroleum fumes, from blasting, sewer gas.	Hydrogen sulfide gas monitor
Carbon Dioxide	CO_2	1.53	Not Flammable		Colorless, odorless, non-flammable. Not generally present in dangerous amounts unless there is already a deficiency of oxygen.	10% cannot be endured for more than a few minutes. Acts on respiratory nerves.	Issues form carbonaceous strata. Sewer gas.	Oxygen deficiency indicator.
Nitrogen	N_2	0.97	Not Flammable		Colorless, odorless, non-flammable. Non-poisonous. Principal constituent of air about 79%	See Hydrogen.	Issues from rock strata. Sewer gas.	Oxygen deficiency indicator.
Ethane	C_2H_4	1.05	3.1	15.0	Colorless, odorless, Non-poisonous, Flammable. Explosive.	See Hydrogen.	Natural gas.	Combustible gas indicator.
Chlorine	Cl_2	2.5	Not Flammable Not Explosive		Greenish yellow gas, or amber color liquid under pressure. Highly irritating and penetrating odor. Highly corrosive in presence of moisture.	Respiratory irritant, irritating to eyes and mucous membranes. 30 ppm causes coughing. 40-60 ppm dangerous in 30 minutes. 1000 ppm apt to be fatal in few breaths.	Leaking pipe connections. Over-dosage.	1. Chlorine gas monitor. 2. Odor.

1. From Water and Sewage Works – Van Kleeck- August 1953.
2. Gases with specific gravity less than 1.0 are lighter than air; those more than 1.0 are heavier than air.
3. The first method given is the preferable testing procedure.

Appendix A – Permits and Reports

A.1 Construction Permit

A.2 Operating Permit

(To be added as addendum.)

A.3 AWMI RME 2018 4th Quarter 4.04 Report

State Permit DEN Number: 359288-01
Effective Date: October 15, 2013
Amended Date: November 3, 2017
Amended Date: August 22, 2018
Expiration Date: October 14, 2019

Spray Irrigation Construction Permit

Issued by: Groundwater Discharges Section
Division of Water
Department of Natural Resources
and Environmental Control
89 Kings Highway
Dover Delaware 19901
302-739-9948

AUTHORIZATION TO CONSTRUCT
UNDER THE LAWS OF THE
STATE OF DELAWARE

PERMITTEE: Artesian Wastewater Management, Inc.
664 Churchmans Road
Newark, DE 19702

FACILITY: Artesian Northern Sussex Regional Water Recharge Facility (ANSRWRF)

1. Pursuant to the provisions of 7 Del. C., 6003, **Artesian Wastewater Management, Inc.** is herein authorized to construct **Phase I** of the **ANSRWRF**:

   Wastewater Treatment Plant Site: The Phase I treatment plant components are to be constructed on Sussex County Tax Map/Parcel Number: 2-35 6.00 28.09 along Route 30 approximately 4,000' north of the intersection of Route 16 and Route 30.

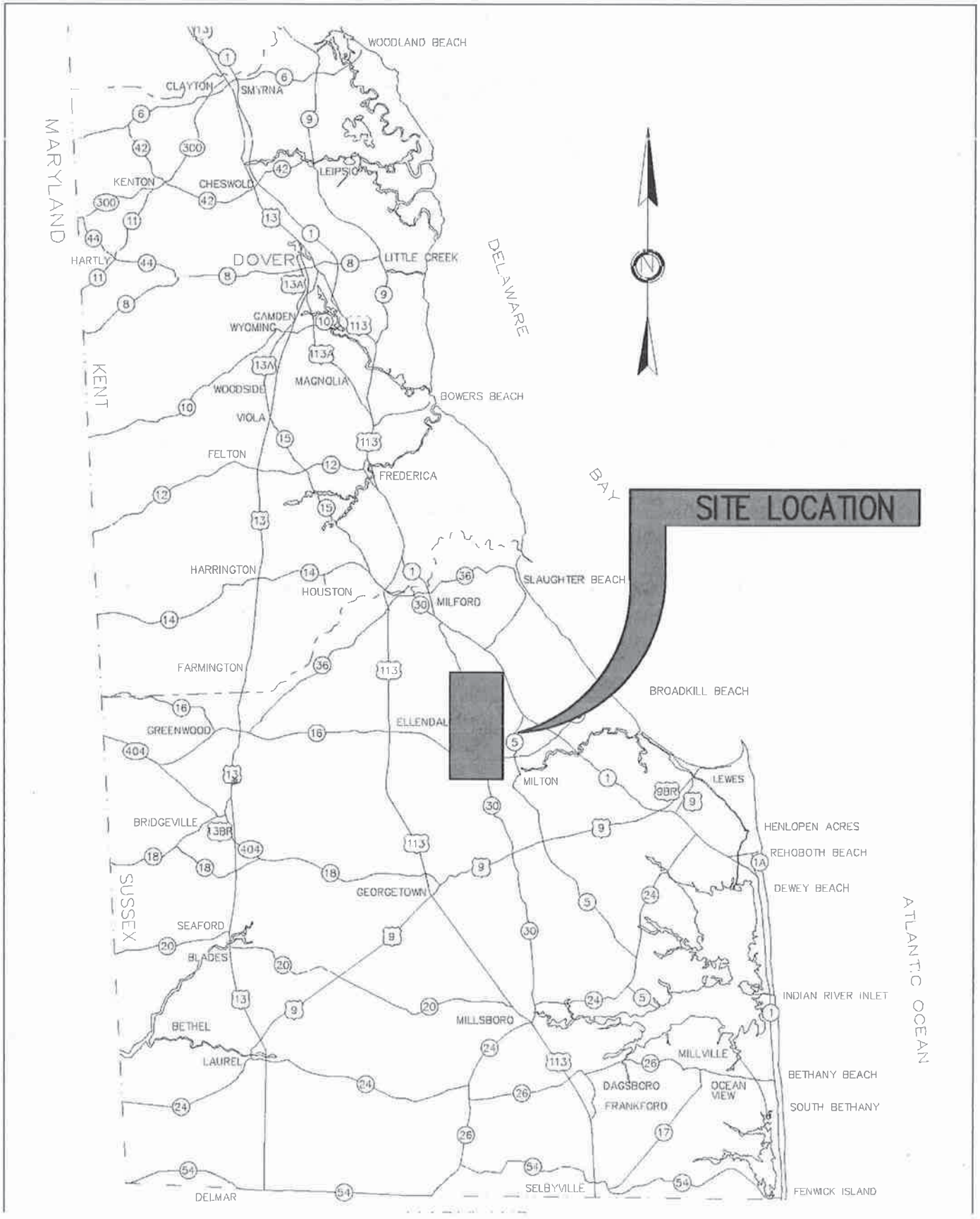
   Spray Irrigation Sites: Sussex County Tax Map/Parcel Numbers listed in Part I.A of this permit.

2. **The construction requirements, and other permit conditions are set forth herein.**

John G. "Jack" Hayes, Jr.
Environmental Program Manager
Groundwater Discharges Section
Division of Water
Delaware Department of Natural Resources
and Environmental Control

8/22/18
Date Signed

LOCATION MAP



Part I

A. GENERAL DESCRIPTION:

Artesian Northern Sussex Regional Water Recharge Facility (ANSRWRF) will serve as a regional facility meeting existing and future wastewater needs within the Artesian Wastewater service territories in Sussex County, Delaware.

The effluent is proposed to be utilized for spray irrigation of privately owned agricultural land, under a lease held in perpetuity by Artesian as the wastewater utility provider. Irrigation Sites are listed below.

The wastewater treatment facility is to be constructed on Sussex County Parcel Number: 2-35 6.00 28.09; located on a 75 acre site south of Reynolds Pond Road, east of Route 30, north of Ingram Branch and Route 16, and west of Cedar Creek Road, Sussex County, Delaware.

The facility will be built in three phases. This Permit authorizes the construction of Phase I only. Phase I of the project is to construct a storage lagoon and disposal spray fields, and to accept treated wastewater from Allen Harim Foods, LLC (Allen Harim). The design average daily flow is 1.5 MGD with a peak daily flow of 2.0 MGD. The customers for Phase I consists of a single food processing source, Allen Harim.

Phase I Spray Irrigation Sites:

Field	Sussex County Tax Map ID	Gross Area[1] (Acres)	Existing Crop Spray Area (Acres)	Proposed Crop Spray Area (Acres)	Proposed Woods Spray Area (Acres)	Total Spray Area (Acres)	Percent Spray (%)
D	235-6.00-11.00 235-6.00-11.01[1] 235-6.00-11.02 235-7.00-1.00 235-7.00-164.00	125.1	45.3	12.7	32.7	90.7	72.5%
E	235-6.00-21.00	119.0	83.2	7.3	0	90.5	76.0%
F	235-7.00-7.00	126.5	110.5	0	0	110.5	87.3%
G	235-13.00-6.05 235-13.00-6.06	590.5	241.9	34.2	195.0	471.0	79.8%
Total		961.1	480.9	54.2	227.7	762.7	

[1]One parcel from Field D (2-35-6-11.01) is not included in the current Conditional Use Ordinance 1923, adopted July 31, 2007. Spray will not permitted on this parcel until it has been added to an approved Conditional Use.

B. DOCUMENTATION:

Construction shall be in accordance with the following documents:

1. The State of Delaware, Department of Natural Resources and Environmental Control, Regulations Governing the Design, Installation and Operation of On-Site Wastewater Treatment and Disposal Systems (Regulations).
2. Secretary's Order No. 2012-W-0052 issued and effective March 12, 2013.
3. May 5, 2017 Application Package for an Amended Construction Permit for the Artesian Northern Sussex Regional Water Recharge Facility (ANSRWRF) Phase 1 submitted by Artesian Wastewater Management, Inc. Application Package includes: Application Form, Amended Design Development Report (DDR), Drawings and Specifications.
4. August 18, 2017 Amended DDR Addendum 1 submitted by Artesian Wastewater Management, Inc. providing additional information requested.
5. Secretary's Order No. 2017-W-0029 issued and effective November 2, 2017.
6. August 17, 2018 Application for a Construction Permit Extension.
7. Any other correspondence, documentation and/or reports related to the ANSRWRF received and approved by the Department's Groundwater Discharges Section and/or sent by the Department's Groundwater Discharges Section.

C. Facility Specific Conditions:

1. In accordance with Secretary's Order No. 2012-W-0052 Issued and Effective March 12, 2013, Permittee shall:
   a. Design the treatment plant to look like an agricultural building and have landscaping to screen it from view from its neighbors.
   b. Ensure that the storage ponds shall not become a breeding ground for mosquitos.
   c. Maintain all required buffers for the spray fields as set by both the Department and Sussex County.
      i. Maintain a 100 foot buffer from the wetted field area to the north-west corner of the Sylvan Acres Development.
2. The permittee shall comply with all applicable Sussex county ordinances and conditional use requirements placed on this facility.
3. Wastewater spray irrigation will not be permitted on Field D parcel (2-35-6-11.01) until it is added to an approved Conditional Use. Parcel 2-35-6-11.01is not included in the current Conditional Use Ordinance 1923, adopted July 31, 2007. Once this parcel has been added to an approved Conditional Use, Permittee must provide a copy of the approved Conditional Use to the Groundwater Discharges Section for approval. Written approval from the Groundwater Discharges Section must be acquired by the permittee prior to wastewater spray irrigation on this parcel.

4. The Department reserves the right to increase required separation/buffer and/or isolation distances at any time for reasons including the following:
   a. Objection by an adjacent property owner due to aerosol migration onto their property;
   b. Change in ownership of adjacent property;
   c. Change in land use of adjacent property.

5. The additional 23 MG storage capacity may not be utilized during Phase I unless under the written authorization of the GWDS or in response to an emergency situation outside the Permittee's control (Force Majeure).

6. The Permittee shall ensure the facility meets the following design criteria:

Table 3-1: Revised Design Summary Table

General Information		
Applicant	Artesian Wastewater Management, Inc.	
Facility Name	Artesian Northern Sussex Regional Water Recharge Facility (ANSRWRF)	
Facility Location	Sussex County, Delaware	
Responsible Official	Rodney Wyatt	
Activities (Phase 1)	Storage & disposal of treated wastewater	
Activities (Future Phases	Treatment, storage, and disposal	
Type of Waste (Phase 1)	Treated food processing	
Type of Waste (Future Phases)	Treated food processing and raw sanitary	
Disposal Method	Spray irrigation to woods and crops	
Type of Spray System	Pivot and Solid Set	
Public Access Level	Unlimited Public Access	
Nearest Weather Station	Georgetown 5 SW	
Watersheds	Broadkill River and Cedar Creek	
Tax Parcel	**Location**	**Area (Acres)**
235-6.00-28.09	ANSRWRF	74.62
230-22.00-1.00	Spray Field A	182.87
230-21.00-35.00	Spray Field B	77.93
230-21.00-35.01	Spray Field B	113.69
230-21.00-13.00	Spray Field B	221.14
235-7.00-27.00	Spray Field C	157.53
235-6.00-11.00	Spray Field D	56.78
235-6.00-11.01 [1]	Spray Field D	6.22
235-6.00-11.02	Spray Field D	10.46
235-7.00-164.00	Spray Field D	32.45
235-7.00-1.00	Spray Field D	19.23
235-6.00-21.00	Spray Field E	118.96
235-7.00-7.00	Spray Field F	126.51
235-13.00-6.05	Spray Field G	515.6
235-13.00-6.06	Spray Field G	74.9

1) See discussion in Section 4.3**Error! Reference source not found.**.

Table 3-1: Revised Design Summary Table (Continued)

Parameter	Value	Units
Influent to Lagoon[1]		
Daily Flow[2]	1.5	MGD
Peak Daily Flow[2]	2.0	MGD
BOD_5	10	mg/L
Total Suspended Solids	10	mg/L
Chlorine Residual	0.5 – 4	mg/L
Turbidity	5	NTU
Fecal Coliform	20	col/100 mL
Total Nitrogen (as N)	30	mg/L
Ammonia (as N)	0	mg/L
Nitrate/Nitrite (as N)	28	mg/L
Total Phosphorus	1.0	mg/L
Lead	0.001	mg/L
Zinc	0.039	mg/L
Copper	0.0072	mg/L
Nickel	0.005	mg/L
Cadmium	0.0005	mg/L
Aluminum	0.2	mg/L
pH	6.0 - 9.0	S.U.
Effluent to Spray		
No further treatment is proposed after the lagoons for Phase 1.		
Storage Volume		
Recommended Minimum Storage (45 day)	67.5	MG
Minimum Required Storage (storage calcs.)	69.0	MG
Phase 1 Available Storage (w/o freeboard)[2]	92	MG
Phase 1 Available Storage[2]	61	days
Surface Area (top of lagoon)	19.4	acres
Surface Area (high water level)	18.8	acres
Surface Area (low water level)	1.6	acres
Freeboard	3	ft
Top Elevation	46.0	ft
High Water Level	43.0	ft
Low Water Level	26.0	ft
Sidewall Slope	2.5:1	

1) Influent values are average daily unless listed otherwise.
2) Design flow is 2 MGD 5 days per week, with an average weekly flow of 1.5 MGD.
3) See discussion in Section 4.7.

Table 3:1: Revised Design Summary Table (Continued)

Parameter	Value	Units
Spray Area		
Total Available Spray Area (gross acreage)	1,714	acres
Phase 1 Wetted Area (initial construction)[1]	471	acres
Phase 1 Wetted Area (total to be permitted)[1]	763	acres
Treatment Site Buffer Distance (property line)	30	ft
Treatment Site Buffer Distance (dwelling)	100	ft
Spray Buffer Distance (watercourse)	100	ft
Spray Buffer Distance (upgradient well)	100	ft
Spray Buffer Distance (downgradient well)	150	ft
Spray Irrigation Nitrogen Balance		
Design Percolate Total N	10	mg/L
Available Crop Area (initial construction)[1]	276	acres
Available Woods Area (initial construction)[1]	195	acres
Available Crop Area (total to be permitted)[1]	535	acres
Available Woods Area (total to be permitted)[1]	228	acres
Crop Plan	Corn-Wheat-Soybean-Cover	
Crop Plan (alternate option)	Corn-Barley-Soybean-Cover	
Corn Annual N Removal	155	lbs/acre/year
Wheat Annual N Removal	89	lbs/acre/year
Barley Annual N Removal	65	lbs/acre/year
Soybean Annual N Removal	189	lbs/acre/year
Cover Annual N Removal	0	lbs/acre/year
Loblolly Pine Annual N Removal	200	lbs/acre/year
Soybean Fixation	40%	% Annual Removal
Precipitation Deposition of N	5	lbs/acre/year
Ammonia Volatilization	5%	% Ammonia
Denitrification	15%	% Total Nitrogen
Max Hydraulic Loading	1.65	in/week
Phosphorus Loading		
Phosphorus Limited	Crop Areas of Fields D, F, and G	
Design Percolate Total Phosphorus	8.0	mg/L
Maximum Annual Spray Volume[2]	3.5	MG/acre-year
Maximum Phosphorus Loading[2]	29.5	lbs/acre-year
Average Annual Crop Removal	31.2	lbs/acre-year
Heavy Metals Loading		
Soil Cation Exchange	0 - 5	meq/100g
Soil Density	1.55	g/cc
Existing Lead in Soil	92.0	mg/kg
Existing Zinc in Soil	34.0	mg/kg
Existing Copper in Soil	13.0	mg/kg
Existing Nickel in Soil	13.0	mg/kg
Existing Cadmium in Soil	0.121	mg/kg
Land Limiting Constituent (LLC)	Zinc	
Site Life based on LLC	93	years

1) See discussion in Section 4.3.
2) This is a conservative estimate based on regulatory maximum spray rate of 2.5 in/wk.

Part II

A. CONSTRUCTION REQUIREMENTS:

1. **This permit authorizes the construction of Phase I only.** Wastewater may not be discharged to the storage lagoons or spray irrigation system under the terms of this construction permit. Upon final approval of construction, the permittee may apply for an operation permit. At that time, additional fees may be required.
2. The permittee shall notify the Department's Groundwater Discharges Section in writing of the intent to initiate construction activities at least fifteen days prior to the commencement of construction. The written notification shall include a draft construction schedule.

   The permittee must provide updated construction schedules if the schedule changes as construction progresses.
3. The permittee shall notify the Department's Groundwater Discharges Section of scheduled construction progress report meetings. The Department's Groundwater Discharges Section staff may attend these meetings.
4. Prior to initiating construction of a large on-site wastewater treatment and disposal system, a pre-construction meeting shall be held on-site and attended by the following individuals: DNREC Soil Scientist, DNREC Environmental Engineer, DNREC Hydrologist, Class D.3 Soil Scientist, Professional Geologist, Project Design Engineer, General Site Contractor, Class E.4 System Contractor and other necessary parties.
5. All systems must be installed by a DNREC licensed Class E.4 system contractor. Proper construction of the treatment plant and/or spray system must be certified in writing by the design engineer and the manufacturer's representative prior to startup of the wastewater treatment plant.
6. The Class E.4 system contractor must notify the Department's Groundwater Discharges Section 72 hours prior to construction startup.
7. The Class E.4 system contractor must obtain an authorization number from the Department's Groundwater Discharges Section prior to initiating construction.
8. Upon receipt of the authorization number, the Class E.4 system contractor shall provide an installation timeline to the Department's Groundwater Discharges Section. Upon receipt of the timeline, the Department's Groundwater Discharges Section may request weekly status reports (verbal) or monthly progress reports (written) be submitted.
9. The Class E.4 system contractor must have a copy of all valid, required and approved permits on site during construction.
10. The design engineer or his/her designee must periodically review the construction of the disposal system to ensure compliance with design specifications.
11. All system components must be surveyed to a common datum point.

12. Soil disturbance to the disposal areas must be limited to the minimum required for installation. A protective barrier must be placed around the disposal areas, including spare area, prior to the initiation of any construction activities. The soils may be rendered unsuitable should unnecessary soil disturbance occur near or within the disposal area. Particular care should be taken when clearing wooded lots so as not to remove the surface soil material (see Lot Clearing Guidelines).
13. If well pointing is required during construction, the wells must be installed by a licensed well driller, and a permit to construct such wells must first be obtained from the Department.
14. All construction activities must be approved by the Department and must comply with all other applicable local utility construction specifications and standards; and must be in accordance with Ten States Standards.
15. Connections and/or additions to the wastewater treatment and disposal system, other than those indicated on the approved plans and specifications, will not be allowed without prior written approval from the Department's Groundwater Discharges Section.
16. Any anticipated facility expansions, production increases, or process modifications that will result in new, different, or increased discharges of pollutants must be reported in writing to the Department's Groundwater Discharges Section for approval. A new permit may be required.
17. Facility and Construction Changes

    The permittee must submit a written report to the Department's Groundwater Discharges Section for review and approval of any changes to the facility or construction of the system within the following time periods:

    a. Thirty days before any planned activity, physical alteration to the permitted facility or addition to the permitted facility if that activity, alteration or addition would result in a change in information that was previously submitted to the Department's Groundwater Discharges Section; or

    b. Thirty days before any anticipated change which would result in noncompliance with any permit condition or the regulations; or

    c. Immediately after the permittee becomes aware of relevant facts omitted from, or incorrect information submitted in, a permit application or report to the Department's Groundwater Discharges Section.
18. The permittee must supply the Department's Groundwater Discharges Section with testing procedures and results conducted on the force main/collection/distribution system (including any lift stations).
19. A construction permit issued by the Department does not relieve the permittee from complying with any local, municipal, county, or state requirement.

20. The Class E.4 system contractor must contact the design Engineer, licensed operator and the Department's Groundwater Discharges Section to schedule an inspection prior to completion of construction.
21. Prior to the issuance of an operation permit the design Engineer shall provide the Department's Groundwater Discharges Section with an approved engineer inspection report(s) demonstrating that system has been constructed in accordance with the approved Design Engineer Report, Plans and Technical Specifications prior to the operation permit being issued.
22. The permittee is responsible for supplying the Department's Groundwater Discharges Section with a certificate or letter of completion/approval from the wastewater treatment plant manufacturer upon construction completion of the wastewater treatment plant, if applicable.
23. Construction activities within spray fields must be minimized. Excessive compaction of surface soils by construction equipment must be avoided. Re-grading of pipeline trenches must match original contours. Settlement of trench backfill must be repaired.
24. In forested systems, it is necessary to only grub the pipe centerline. Excessive clearing and grubbing must be avoided. Clearing for above-ground piping systems shall involve only vegetation that will interfere with operation of the system.
25. All areas disturbed by construction must be re-vegetated prior to initiation of irrigation activities.
26. Sloped areas require protection from erosion.
27. Pressure testing of the irrigation force mains and laterals shall be conducted during installation to avoid damage to spray fields from re-excavation and repair. Flushing is necessary to clear distribution system pipes of construction debris which will clog sprinkler nozzles. Care should be exercised to prevent erosion or flooding of the spray fields during pipeline flushing. Every effort should be made to keep trash and debris out of the distribution systems. Sprinklers and drain valves shall be checked for proper operation prior to installation.
28. Wastewater irrigation on bare soil is not allowed beyond what is necessary for germination to establish a vegetative cover. Wastewater application, at the design rate, may begin only after a uniform vegetative cover has been established.
29. Spray fields should be constructed early in the project so a vegetative cover can be re-established on disturbed areas before wastewater irrigation begins.
30. Potable, ground or surface water must be used for distribution system testing unless authorized in writing by the Department's Groundwater Discharges Section.
31. One growing season may be necessary before new spray fields will accept the design wastewater loading. This start-up period must be considered in the design and operation of these systems.

32. If testing of the system is required prior to construction completion that will require the operation of the system or the discharge of treated wastewater, the permittee must request approval in writing from the Department's Groundwater Discharges Section and must notify the Groundwater Discharges Section of the scheduled testing so that Groundwater Discharges Section staff may be present during the testing of the system.
33. No industrial or commercial discharges may be connected to the facility without prior written approval from the Department's Groundwater Discharges Section.
34. The permittee shall take all reasonable steps to minimize any adverse impact to waters of the state resulting from construction under this permit. Such steps shall include, but not be limited to, accelerated or additional monitoring as necessary to determine the nature and impact of the non-complying discharge or reasonable mitigation of such impacts.
35. The Permittee must obtain appropriate state permits for the collection and distribution system.
36. Information for each monitoring well and piezometer shall be reported using the State of Delaware Well Identification Tag Number that is required on all wells in accordance with the Delaware Regulations Governing the Construction and Use of Wells, Section 10, A.

B. MONITORING REQUIREMENTS

1. The permittee must have a licensed well driller install all required monitoring wells, piezometers and lysimeters at the locations approved by the Department's Groundwater Discharges Section and identified on the Drawings submitted as referenced on Part I.B of this permit. The permittee shall contact the Department's Groundwater Discharges Section at least 24 hours prior to the installation of the monitoring wells. All monitoring wells must be installed by a licensed well driller, and a permit to construct the wells must first be obtained from the Department.
2. After installation, the permittee must have all monitoring wells globally positioned. The GPS information must be submitted to the Department's Groundwater Discharges Section with the locations of the wells delineated on the As-Built Drawings. The GPS information must be in either Delaware State Plane, North American Datum 1983 meters; or Latitude and Longitude decimal degrees.
3. Prior to well purging and groundwater sampling, the elevation of a reference marking on the upper terminus of each monitoring well casing (TOC) shall be surveyed by a Delaware-licensed PLS to the nearest 0.01 ft relative to a common mean sea level datum. The elevation of the ground surface immediately adjacent to each monitoring well shall also be surveyed as previously prescribed. All elevation data pertaining to monitoring wells shall be indicated on "as-built" plans and summarized in a report. Provide a permanent mark, etch, or fixture to be used to specify the survey point where the TOC elevations were read. Ensure that the water levels are consistently taken directly below the points where the TOC elevations were read.

4. The permittee shall conduct a background groundwater quality sampling program prior to initiation of disposal activities. The sampling program shall be sufficient to establish representative groundwater quality at each well prior to initiation of disposal activities. A minimum of three samples shall be collected at least one month apart and analyzed prior to the initiation of disposal activities. A summary report which includes all analyses must be submitted to the Department's Groundwater Discharges Section. Analyses must include, the parameters listed in Section 6.8.1.8.
5. Sampling parameters and frequencies will be outlined in the operation permit.

C. REQUIREMENTS PRIOR TO ISSUANCE OF AN OPERATING PERMIT

1. The Permittee shall notify the Department's Groundwater Discharges Section in writing prior to the completion of construction and request a Construction Completion Inspection to be performed by the Department's Groundwater Discharges Section staff. The Design Engineer, Class E.4 system contractor, licensed operator and the Permittee must be present during the inspection. During the inspection, all mechanical parts are to be tested.
2. A classification shall be performed on the facility in accordance with Regulations Licensing Operators of Wastewater Facilities. The class of operator required for the facility will be determined by the Board of Certification for Licensed Wastewater Operators in accordance with the Regulations Licensing Operators of Wastewater Facilities. All large systems must be under the direction of a licensed operator. The licensed operator must be available at all times. The licensed operator shall be on-site at the time the system is put into operation and is to receive all training as necessary to properly operate the system.
3. Upon completion of construction, an operation permit must be obtained from the Department's Groundwater Discharges Section prior to system operation. The permittee must submit to the Department's Groundwater Discharges Section the following applicable items in application for an operations permit. The items must be combined in one package and must include an electronic copy of all items where possible. Failure to submit all required information constitutes grounds for denial of the operation permit.
   a. A Department application form.
   b. Applicable Departmental fees.
   c. Design Engineer Inspection Report(s) certifying the facility has been constructed in accordance with approved plans and specifications.
   d. Copies of any other applicable State/County inspection reports.
   e. Contractor's Certificate of Completion.
   f. A certificate or letter of completion/approval from the wastewater treatment plant manufacturer.
   g. A copy of the agreement with a licensed operator and license certification.
   h. A copy of the agreement with a regulated wastewater utility in the State of Delaware that the treatment facility will be operated under.
   i. A set of "as-built" drawings of the facility bearing the seal and signature of a licensed Professional Engineer registered in the State of Delaware.

      The "as-built" drawings must include:

      i. Site map showing the location of all structures, piping and appurtenances, disposal areas and buffers.
      ii. A full equipment list and technical specifications for all equipment used, if different than submitted in the permit application.
      iii. The new topography elevations of the system.

iv. Monitoring/Observation well elevations at the top of the casing (TOC) and at the ground surface, GPS coordinates (State Plane), and local topography tied to a common benchmark.

v. The location and screen depth, length of stick up, and well ID's must be provided for each monitor well.

j. A copy of all Collection System Permit(s)

k. Inspection Reports demonstrating collection system has been installed and inspected by Design Engineer

l. If the collection system does not require county approval, the permittee must supply the Department's Groundwater Discharges Section with all testing procedures conducted on the collection system, force main(s) and lift station(s).

m. An Operation and Maintenance (O&M) Plan in accordance with Section 6.7 of the Regulations.

n. Spreadsheet summary of groundwater monitoring well information.

i. GPS information detailing the northings and eastings; the local well ID number; and the DNREC Well ID/Well Permit Number. The GPS information must be in either Delaware State Plane, North American Datum 1983 meters; or Latitude and Longitude decimal degrees.

ii. TOC elevations survey results for all monitoring wells to be utilized for groundwater monitoring. Provide the length of the well stickup and the well survey information to the closest 0.01 feet. Provide a permanent mark, etch, or fixture to be used to specify the survey point where the TOC elevations were read.

o. A summary report detailing the analyses of the background groundwater quality sampling program that was conducted consisting of at least three (3) samples one (1) month apart and analyzed prior to the initiation of disposal activities (see Section 6.6.3.16 of the Regulations).

p. Biosolids Management Plan. A copy of a biosolids management contract if a third party will be utilized to manage the biosolids. If the Permittee is not contracting out sludge management, the Permittee must obtain any necessary permits for land application of biosolids from the Department and provide a copy to the Groundwater Discharges Section.

q. Legal documents (see Section 6.4 of the Regulations)

r. Material Safety Data Sheets for all chemicals to be used by the facility staff/operator.

Part III

A. MANAGEMENT REQUIREMENTS AND RESPONSIBILITIES

1. Right of Entry

   The permittee shall allow the Department entry and access, consistent with 7 Del.C. Ch. 60, to:

   a. Enter the permitted facility.

   b. Inspect any records that must be kept under the conditions of the permit.

   c. Inspect any facility, equipment, practice, or operation permitted or required by the permit.

   d. Sample or monitor for the purpose of assuring permit compliance of any substance or any parameter at the facility.

2. Permit Transferability

   Permits may be transferred to a new owner or operator. The permittee must notify the Department's Groundwater Discharges Section by requesting a change of ownership of the permit before the date of transfer. The transfer must be consistent with any notarized legal documents and/or CPCN required by the Regulations. The legal documentation must be provided with the application. The application must be received 30 days before the transfer.

   a. No person shall transfer a permit from one person to another unless 30 days written notice is given to the Department's Groundwater Discharges Section, indicating the transfer is agreeable to both persons, and approval of such transfer is obtained in writing from the Department's Groundwater Discharges Section, and any conditions of the approval of such transfer is obtained in writing from the Department's Groundwater Discharges Section, and any conditions of the transfer approved by the Department's Groundwater Discharges Section are complied with by the transferor and the transferee.

   b. The notice to the Department's Groundwater Discharges Section shall contain a written agreement between the transferor and the transferee, indicating the specific date of proposed transfer of permit coverage and acknowledging responsibilities of current and new permittees for compliance with and liability for the terms and conditions of this permit. The notice shall be signed by both the transferor and the transferee.

3. Availability of Reports

   All reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Department of Natural Resources and Environmental Control. Monitoring data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in 7 Del. C., §6013.

4. Non-compliance Notification

   The Permittee shall report to the Department's Enforcement Section at (800) 662-8802 any unpermitted release or discharge of any contaminant into the air, or a pollutant, including petroleum substances, into surface waters, groundwater, or onto land as soon as the Permittee has knowledge of, or should have had knowledge of, the release or discharge.

   The Permittee shall report to the Department's Groundwater Discharges Section orally within 24 hours from the time the Permittee became aware of any noncompliance that may endanger the public health or the environment by contacting the Department at the telephone numbers cited below.

   If for any reason the Permittee does not comply with, or will be unable to comply with, any effluent limitations or other conditions specified in this permit, the Permittee shall provide the Department's Groundwater Discharges Section with the following information in writing within five days of becoming aware of any actual or potential non-compliance:

   a. A description and cause of the non-compliance with any limitation or condition;

   b. The period of non-compliance including exact dates and times; or, if not yet corrected, the anticipated time the non-compliance is expected to continue; and

   c. The steps being taken or planned to reduce eliminate and/or prevent recurrence of the non-compliant condition.

   The notification shall be submitted to the Department at the following address:

   Groundwater Discharges Section
   Division of Water
   Department of Natural Resources and Environmental Control
   89 Kings Hwy
   Dover DE 19901
   Telephone: (302) 739-9948 Office
   (302) 542-9735 Cell

5. Construction Permit Expiration

   a. If construction has not been initiated prior to the expiration of the construction permit, and there are proposed changes to the approved design, the applicant must submit a new or updated Design Engineer Report and construction plans as outlined in Sections 6.2.3, 6.5.1.4 and 6.5.1.5 for project re-evaluation. This will require public notification.

   b. If construction has been initiated prior to the expiration of the construction permit, and construction has not been completed prior to the expiration of the permit, the permittee may apply for a one year extension of the construction permit.

   c. If construction has not been initiated or construction has not been completed prior to the expiration of the one year extension, provided, the SIR is valid, and there are no changes to the approved design prior to the expiration of the construction permit, the applicant must submit a construction permit application along with applicable fees, and a construction schedule.

6. Construction Permit Extension

   The application for extension must include the following:

   a. A Department extension form

   b. Applicable Departmental fees

   c. Construction schedule

PART IV

A. PROVISIONS

1. Permit Revocation

   The Department may revoke a permit if, among other things, the permittee violates any permit condition, these regulations, fails to pay applicable Departmental fees, obtains the permit by misrepresentation or fails to fully disclose all relevant facts.

   Except in cases of emergency, the Department shall issue a written notice of intent to revoke to the permittee prior to final revocation. Revocation shall become final within 20 days of receipt of the notice by the permittee, unless within that time the permittee requests an administrative hearing in writing.

   The Department shall notify the permittee in writing of any revocation hearing at least 20 days prior to the date set for such hearing.

   If the Department finds the public health, safety or welfare requires emergency action, the Department shall incorporate findings in support of such action in a written notice of emergency revocation issued to the permittee. Emergency revocation shall be effective upon receipt by the permittee. Thereafter, if requested by the permittee in writing, the Department shall provide the permittee a revocation hearing.

2. Permit Modifications/Amendments

   In consultation with the permittee, the Department may modify or amend an existing permit provided that the modifications would not result in an increased impact or risk to the environment or to public health.

3. State Laws

   This permit shall not be construed to preclude the institution of any legal action or relieve the Permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or regulation.

4. Property Rights

   The issuance of this permit does not convey any property rights of either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state or local laws or regulations.

5. Severability

   The provisions of this permit are severable. If any provision of this permit, or the application of any provision of this permit, to any circumstances is held invalid; the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

6. This permit does not relieve the Permittee of complying with any other applicable Federal, State or local regulations.
7. In the event that the Regulations Governing the Design, Installation and Operation of On-Site Wastewater Treatment and Disposal Systems or applicable federal regulations are revised, this permit may be opened and modified accordingly after notice and opportunity for a public hearing.

September 25, 2018

ATTN: Nicole Smith
State of Delaware DNREC/
Division of Water Resources
89 Kings Highway
Dover, DE 19901

RE: DNREC 4.04 4th Quarter Reports

Dear Ms. Smith:

Enclosed, please find the 4th Quarter 4.04 Report.

If you have any questions, please do not hesitate to contact me at 302-420-0372.

Sincerely,

Artesian Wastewater Management,Inc.

Mark A. Kondelis Sr.
Manager of Wastewater Services
Artesian Resources Corp.

Certified Mail #7015 1520 0003 1684 7105

4th Quarter 4.04-2018

Operators	License	License Level	Facilities	DRC	Back-up DRC	Years DRC (2), 4 Max. = X	Years DRC (3/4), 6 Max. = X	Employment Start Date as WW op
Bowden, Sean	721	4OIT	1,2,3,4,5,6	3A	3,6	X	3.5	8/1/2009
Campbell, Keith	748	2	3,4,5,6	N/A	N/A	0	1.25	12/3/2010
Hamilton, Beth	803	4	1,2,3,4,5,6	1A & 2B	1	X	X	3/1/2009
Haynes, Samuel	333	3	1,2	2	N/A	0	X	2/1/2010
Kondelis Sr., Mark	280	4	1,2,3 ,4,5,6	N/A	N/A	X	X	8/1/2000
Lynn, John	747	2	3,4,5,6	4B	N/A	0	0.75	3/1/2011
McClure, Douglas	637	4	1,2,3,4,5,6	1 & 2A	2	0	X	11/1/2009
Plack, Richard	645	4	1,2,3,4,5,6	3,4	5	X	X	3/1/2008
Poore,Stephen	899	1	1,2	N/A	N/A	0	0	11/4/2013
Shenk, Barry	900	2	1,2,3,4,5,6	N/A	N/A	0	0	10/1/2013
Siegfried, Stan	164	2	1,2,3,4,5,6	4A	N/A	0	0.75	2/5/2013
Suare,Javier	989	2OIT	3,4,5,6	3B	N/A	0	0.75	2/20/1996
Michael Tingle	912	2	1,2,3,4,5,6	6	4	0	0	4/4/2018
Horace Brown	855	1	1,2	1B,1C	N/A	0	0.25	5/29/2018
Facility	**#**	**Level**	**Location**	**Type**				
Middletown WWTP	**1**	4	Middletown DE	A				
Lagoons & Filter Plant	1A							
Spray Fields	1B							
Disinfection & Spray Control	1C							
Frog Hollow	**2**	3	Middletown DE	B				
Treatment Lagoons	2A							
Filter Building	2B							
Stonewater Creek	**3**	3	Longneck DE	B				
Treatment Plant	3A							
RIB's	3B							
Beaver Creek	**4**	3	Harbeson DE	B				
Treatment Plant	4A							
RIB's	4B							
Reserves at Lewes	**5**	2	Lewes DE	D				
Heron Bay	**6**	2	Lewes DE	C				
X means all requirements met.								

664 Churchmans Road, Newark, Delaware 19702, P.O. Box 15004 Wilmington, Delaware 19850 Phone: (302) 453-6900 Fax: (302) 453-6957
14701 Coastal Highway, Milton, Delaware 19968 Phone: (302) 645-7751 Fax: (302) 645-8233
email: artesian@artesianwater.com Website: artesianwater.com

Appendix B - Vegetative Management Plan

Vegetative & Nutrient Management Plan For The Spray Irrigation Of Treated Wastewater

Prepared for

Artesian Northern Sussex Regional Wastewater Recharge Facility (ANSRWRF)

Prepared By

Todd A. Keen
Certified Comprehensive Nutrient Management Planner
TSP# 05-4996

KEEN CONSULTING

26229 Prettyman Road
Georgetown, DE 19947
(302) 684-5270
(302) 684-5273 FAX

Introduction

Artesian Wastewater Management, Inc. proposes to design, build and operate a wastewater treatment facility known as the Artesian Northern Sussex Regional Water Recharge Facility (ANSRWRF) on a 75 acre site located off Isaacs Road (Route 30) just north of the Milton Ellendale Highway (Route 16) in eastern Sussex County Delaware near the town of Milton. The facility is expected to process wastewater generated from various proposed and existing communities in the region.

Processed wastewater from the facility will be land applied via spray irrigation to various parcels of croplands and woodlands of Harry Isaacs, Jr. consisting of approximately 1,722 acres.

This Vegetative Management Plan (VPM) is a guidance document intended to account for the use of the wastewaters on both agricultural croplands and woodlands in an environmentally sound manner. It will provide guidance on wastewater handling and application rates along with crop rotations and expected yields, nutrient management planning, maximum loading rates and other supporting documentation.

Overview – Application Sites

All of the land for the application of effluent is owned by Harry Isaacs, Jr. Agricultural lands are currently leased out for the purposes of crop production. These lands are currently enrolled in Delaware's Agricultural Lands Preservation Program and therefore are required to remain in agricultural related activities. Any lessee's of the agricultural lands will be required to conform with the associated NM plans.

Soils are mostly very well drained sandy loams. Water holding capacities are generally low. Croplands are relatively high yielding soils used to grow small grains, corn, soybeans and hay. Woodlands are a mixture of various hardwoods, spruce and pines.

Spray Irrigation

Treated wastewater for land application will be applied via overhead center pivot irrigation to agricultural croplands and via fixed set sprinklers to woodlands. Wastewater will be directed throughout the network of application systems based upon available water and storage capacities, crop needs, weather, previous application history and hydraulic loading restrictions. Any applicable buffer requirements for wastewater applications will be maintained.

Application Restrictions

Wastewater applications will be limited to a maximum of 2.5" per week throughout the year. Applications will be timed whenever possible to times of greatest crop needs and limited in the winter and times of poor soil and weather conditions. Applications during times of frozen and/or saturated soils should only occur when absolutely necessary.

These applications cannot result in runoff to adjacent properties, tax ditches or water bodies.

The operators should utilize as much storage capacity as possible during the winter months and periods of inclement weather (saturated/frozen ground) and/or low crop moisture demands. Treatment processes should maximize nitrogen removal in treatment processes when not beneficial to crops. Operators should spread wastewater application across all available land in a manner that best utilizes nutrients and supplied moisture to enhance crop growth. Coordination between the operators of the plant and the farming operations along with nutrient management planners concerning wastewater application frequencies, timing and amounts are encouraged to maximize the agronomic benefits while minimizing any negative environmental impacts (runoff, drift, etc.).

Nutrient Management Planning (NMP)

The NMP is a constantly changing set of documents that is the heart of the VMP. The NMP will be updated annually and will comply with Delaware Nutrient Management Regulations. Nutrient recommendations will be based upon the latest data (soil tests, yield, crop rotations, etc.) with consideration given to economics and environmental impacts in order to ensure the long term sustainability of the operations. Nutrients from both wastewater and other organic and inorganic sources are to be addressed in the NMP. Other practices such as (but not limited to) available nitrogen testing and plant tissue testing may be utilized to better monitor crop performance and adjust the NMP and/or wastewater applications to improve crop performance and/or reduce negative environmental impacts. Yield goals based upon average historical yields along with nitrogen and phosphorous uptake rates for the various crops are provided as a general reference in Table 1 (page 6). Individual site specific yield goals are to be included as a component of the NMP.

Proper agronomic practices such as good pest control strategies, tillage, timely planting, harvesting, and applications, irrigation scheduling, etc. should be utilized to maximize crop performance.

General Cropping Information

The cropping sequence employed on the effluent treated land is a corn/small grain/soybean/small grain (cover crop) rotation. All crops are harvested and sold to be utilized as animal feed. Crops are maintained in all of the spray irrigation fields on a year round basis with the exception being during brief transition times between harvesting and the establishment of succeeding crops. Generally no-till and minimum-till methods (low soil disturbance) are employed. More intensive tillage is occasionally employed if environmental conditions necessitate. Supplemental fertilization is performed to account for nutrient needs not supplied via effluent applications. Liming of the soils is also performed in order to maintain a pH that is advantageous to proper crop growth. These activities are dictated by the NMP and utilize soil and plant tissue test

results as a basis for decision making. Generally speaking a relatively equal split in the cropping mix on an annual basis is desired.

Corn

Corn is planted after the termination of the winter cover crop (small grain). No-till or minimum-till planting methods are usually employed. Planting occurs in mid-April to mid-May. Supplemental fertilizer (starter, pre-plant, etc.) may be applied at this time to address any additional nutrient needs.

Approximately 4-6 weeks after crop emergence soil nitrate testing is performed to help gauge nitrogen available for crop growth. Test results along with previous and anticipated effluent contributions are then utilized for the purposes of a supplemental nitrogen fertilization recommendation being provided through the certified planner.

Corn is harvested in September to early October. Yields generally range in the 200-250 bu/acre range with a "typical" yield being 225 bu/acre. Corn stover is occasionally harvested and a yield of approximately 1.9 tons/acre would be expected when this occurs.

Small Grain

Small grain (barley and wheat) is planted in late September through late October. Both barley and wheat are utilized as cover or harvestable crops dependent upon the cropping rotation in a given field for a given year. Additions of lime and potassium fertilizers as dictated by soil test results are usually performed at this time.

For small grain being taken to grain harvest, a determination of anticipated supplemental crop nitrogen needs is made in early March. This is to be done in a collaborative fashion between the farmers, certified consultant and Artesian personnel. This recommendation is based upon many factors which include crop condition, yield expectations, climatic conditions and contributions from both applied and anticipated applications of effluent water.

Small grains are harvested from mid-June through early July. Barley yields range from 65-95 bu/acre with 85 bu/acre being a "typical" expected yield. Wheat yields range from 65-100 bu/acre with 85 bu/acre being "typical". On occasion wheat and barley straw may also be harvested. Straw yields would be expected to range from 2,400-3,000 lbs/acre. Soybeans are planted immediately following the small grain harvest utilizing the no-till method of farming practices.

Soybeans

Soybeans are normally planted as a "double crop" following small grain harvest. Occasionally due to environmental conditions a "full season" crop of soybeans may be utilized within the rotation. Full season soybeans would be planted in mid-May to early

June. Expected full season soybean yields would be 60-70 bu/acre. Double crop soybeans are planted in mid-June through early July with an expected yield of 50-60 bu/acre.

There is generally no supplemental fertilization of double crop soybeans beyond foliar applications of needed nutrients (minor elements) as dictated by soil and plant tissue test results and environmental conditions.

Reed Canarygrass

Reed canarygrass is not currently a part of the cropping sequence but may be employed should conditions dictate. If utilized it would be established in either the spring (April) or fall (September) and maintained as a perennial crop. Any necessary supplemental fertilization beyond anticipated effluent contributions would be performed in early spring (March/April) and fall (Sept/October). Expected annual yield would be 4 tons/acre.

Forestland

The associated woodlands are a mixture of hardwoods and pines that were harvested and reseeded in 2015. There is no fertilization of the forestlands beyond the contributions provided through the application of effluent. An expected harvest/planting cycle of 30 years is anticipated.

Crop Yields

Table 1 is provided below as a reference for the yields and nutrient removal rates of the various crops for the purposes of system design.

Table 1

Crop Yields Overview and Estimated Removal Rates (System Design)							
Crop*	Yield	Moisture %	Units	Nitrogen Removal per Unit	Nitrogen Removal (lbs/acre @ Yield	Phosphorous Removal per Unit	Phosphorous Removal (lbs/acre @ Yield
Corn	225	15.5	bu/acre	0.69	155.25	0.40	90
Corn Stover	1.9		tons/acre	18.3	34.8	2.0	
Barley	85	14.0	bu/acre	0.76	64.6	0.23	19.6
Barley Straw	1.35		tons/acre	15.0	20.25	5.0	
Wheat	85	13.0	bu/acre	1.05	89.25	0.30	25.5
Wheat Straw	1.35		tons/acre	18.0	24.3	2.0	
Cover Crop	Not Harvested				40	N/A	
FS Soybeans	60	13.0	bu/acre	3.44	206.4	0.82	49.2
DC Soybeans	55	13.0	bu/acre	3.44	189.2	0.82	45.1
Reed Canarygrass	4	11.0	tons/acre	30.3	121.2	5.05	20.2
Forestland Pine/Hardwood Mix	N/A						

*Reed Canarygrass nutrient removal information provided by USDA/NRCS
*All other crop nutrient removal rates provided by University of Delaware

Summary

Nutrient management planning is performed on an on-going basis throughout the year. It is done as collaborative effort between the farmers, consultant and Artesian personnel to ensure permit compliance along with the goal of achieving a successful farming outcome. At a minimum, soils analyses are performed on an annual basis (fall season) along with any needed in-season testing deemed appropriate to the given situation. Historical data along with past and anticipated environmental conditions are also significant to the nutrient management planning and implementation process.

Appendix C – Calculations

Note: The printouts are for reference only. Digital versions of the spreadsheets will be used as a tool for forecasting operations.

Water Balance Calculations

Design Criteria

Parameter	Units	Value
Limiting Soils Permeability Rate[1]	in/hr	3
Design Hydraulic Permeability[2]	in/hr	0.3
Design Hydraulic Permeability	in/day	7.2
Allowable Spray Rate (Soil Capacity)[3]	in/week	49.3
Allowable Spray Rate (Regulatory)[4]	in/week	2.5
Allowable Spray Rate (Hydrogeologic Modeling)[5]	in/week	1.65

Month	Days	Evap. (PET)[6] (in/month)	Precip (P5)[7] (in/month)	Percolation[8] (in/month)	Soil Spray Capacity[9] (in/month)	Soil Spray Capacity (in/week)
January	31	0.1	4.7	223.2	218.6	49.4
February	28	0.1	4.4	201.6	197.3	49.3
March	31	0.7	5.6	223.2	218.3	49.3
April	30	1.8	4.5	216.0	213.3	49.8
May	31	3.3	5.0	223.2	221.5	50.0
June	30	4.8	5.1	216.0	215.7	50.3
July	31	5.5	6.3	223.2	222.4	50.2
August	31	4.9	8.2	223.2	219.9	49.7
September	30	3.6	5.2	216.0	214.4	50.0
October	31	1.9	5.4	223.2	219.7	49.6
November	30	0.9	4.6	216.0	212.3	49.5
December	31	0.2	5.2	223.2	218.2	49.3

1) Permeability in the most restrictive horizons exceeds 3 inches/hour across all proposed fields (Fields A - G). See Executive Summary of the Soil Investigation Report (Brickhouse Environmental, 6/19/2009).
2) 10% of actual permeability. See DNREC On-Site Wastewater Treatment Regulations, Section 6.3.2.3.13.6 (January 2014).
3) Based on minimum calculated Soil Spray Capacity. These calculations demonstrate that soil permeability is not a limiting factor for spray application rate.
4) Maximum allowable spray rate. See DNREC On-Site Wastewater Treatment Regulations, Section 6.3.2.3.13.8.1 (January 2014).
5) Hydrogeological Mounding Model (3/2/2010) assumed maximum spray of 1.65 in/week for ANSRWRF.
6) Thornthwaite Potential Evapotranspiration. See DNREC Exhibit J-J (January 2014).
7) 5-Year Return Period Monthly Precipitation Data. See DNREC Exhibit K-K (January 2014).
8) Design Hydraulic Permeability * Days per month
9) Percolation + Evapotranspiration - Precipitation

Heavy Metals Site Assimilative Capacity Calculations

Cumulative Metal Loading Limit for Spray Irrigation Systems (7 Del.C. Ch. 60 Exhibit H-H)

	Soil Cation Exchange Capacity (meq/100g)		
	0 - 5	5 - 15	>15
Metal	**Cumulative Limit (lbs/acre)**		
Lead (Pb)	500	1000	2000
Zinc (Zn)	250	500	1000
Copper (Cu)	125	250	500
Nickel (Ni)	125	250	500
Cadmium (Cd)	4.4	8.9	17.8

Effluent Sample Data Provided By Allen Harim Foods LLC

Sample Date	Lead (mg/L)	Zinc (mg/L)	Copper (mg/L)	Nickel (mg/L)	Cadmium (mg/L)
2/22/2017	<0.001	0.039	0.0072	0.005	<0.0005
2/28/2017	<0.001	0.025	0.0037	0.0041	<0.0005
3/22/2017	<0.001	0.038	0.0047	0.0074	<0.0005
3/27/2017	<0.001	0.034	0.0047	0.0059	<0.0005
Design Value	**0.001**	**0.039**	**0.0072**	**0.0074**	**0.0005**

Metal	Design Concentration (mg/L)[1]	Max Annual Loading (lbs/acre)[2]	Existing Metals in Soil (mg/kg)[3]	Existing Metals in Soil (lbs/acre)[4]	Cumulative Limit (lbs/acre)[5]	Available Loading (lbs/acre)	Site Life Expectancy (Years)[6]
Lead (Pb)	0.001	0.029	92.0	387.6	500	112.4	3,815
Zinc (Zn)	0.039	1.149	34.0	143.2	250	106.8	93
Copper (Cu)	0.0072	0.212	13.0	54.8	125	70.2	331
Nickel (Ni)	0.0074	0.218	13.0	54.8	125	70.2	322
Cadmium (Cd)	0.0005	0.015	0.121	0.5	4.4	3.9	264

1) Design concentration is a conservative estimate based on the maximum sampled value.
2) Max Annual Loading is a conservative estimate based on maximum allowable hydraulic loading of 2.5 inches per week for 52 weeks.
3) Existing Metals in Soil is a conservative estimate based on the highest sample value from all proposed fields (A-G). See Appendix C, Table 2 of the Soil Investigation Report (Brickhouse Environmental, 6/19/2009).
4) Assumed soil density for Sandy Loam and Loamy Sand is 1.55 g/cc (USDA, Estimating Moist Bulk Density by Texture, https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/office/ssr10/tr/?cid=nrcs144p2_074844)
5) Soil Cation Exchange Capacity <= 5 meq/100g for all proposed fields (A-G). See Appendix C, Table 1 of the Soil Investigation Report (Brickhouse Environmental, 6/19/2009).
6) Available Loading / Max Annual Loading

Phosphorus Balance Calculations

Year	Crop[1]	Annual P Removal[2] (lbs/acre)
Year 1	Barley	13.1
	Soybean	17.5
Year 2	Corn	32.3
Year 3	Barley	13.1
	Soybean	17.5
3-Year Total		93.5
Annual Average Removal		**31.2**

1) Anticipated typical planting is Corn, Wheat, and Soybean, but calculations are done replacing Wheat with Barley, which is more conservative due to lower Phosphorus uptake.
2) Based on University of Delaware (http://extension.udel.edu/factsheets/phosphorus-removal-by-delaware-crops/), with yield assumptions provided by Keen Consulting.

Design Criteria

Parameter	Unit	Value
Average Effluent Phosphorus Concentration	mg/L	<0.05
Design Phosphorus Concentration	mg/L	1.0
Design Phosphorus Concentration	lbs/MG	8.3
Maximum Hydraulic Application Rate	inches/week	2.5
Maximum Spray Periods per Year	weeks/year	52
Maximum Annual Spray Volume	MG/acre-year	3.5
Maximum Phosphorus Loading at Design Conc.	lbs/acre-year	29.5
Annual Average Crop Removal	lbs/acre	31.2

Based on Mehlich III phosphorus tests performed by Brickhouse Environmental, none of the wooded areas in Fields D-G have high phosphorus (>150 ppm). The crop areas in Fields D, F, and G show high phosphorus, so the proposed management approach is to limit the application of phosphorus to the three-year removal rate. Note that Field E does not have high phosphorus, so is exempt from these limitations.

These calculations demonstrate that even if the annual average phosphorus is 20 times higher than the non-detect values currently sampled, and even if spray was continuously applied at the maximum allowable rate, phosphorus loading would still be lower than the average plant uptake.Therefore, phosphorus is not anticipated to be a limiting factor for spray.

For phosphorus limited sites, the total annual phosphorus applied through spray irrigation and fertilizer should be tracked to ensure that the three year crop removal rates are not exceeded.

Nitrogen Balance Calculations

Facility: ANSRWRF - Phase 1

Field: Field G Crop Areas

Scenario: Design 2-Year Cycle, Maximize Monthly Spray, Limit 1.65 in/week

Design Criteria

	Parameter	Units	Value	Notes
1	Crop Management Plan Name		Corn-Wheat-Soybean	*Anticipated typical planting is Corn-Wheat-Soybean, but calculations are done using Corn-Barley-Soybean which is more conservative due to lower TN uptake.
2	Available Wetted Spray Area	(acre)	276.06	
3	Maximum Allowed Spray Rate	(in/week)	2.5	*Maximum 2.5 in/week per regulations, or more restrictive value from Water Balance Calculations.
4	Design Maximum Spray Rate	(in/week)	1.65	*Note: 3/2/2010 Hydrogeological Mounding Model assumed maximum spray of 1.65 in/week for ANSRWRF.
5	Annual Nitrogen from Precipitation	(lb/acre)	5	*Based on National Atmospheric Deposition Program NTN data for Site DE99, 2003-2008.
6	Compute Fertilizer?		TRUE	*If TRUE than fertilizer will be maximized after spray rate is determined. If FALSE then fertilizer will be set to zero.

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
7	Calendar days per month	days/mo	31	28	31	30	31	30	31	31	30	31	30	31	**365**	31	28	31	30	31	30	31	31	30	31	30	31	**365**
8																												
9	**Hydraulic Spray Application**																											
10	Spray hydraulic application rate[1]	in/week	0.44	0.47	0.46	0.39	1.48	1.65	1.65	1.65	0.18	0.29	0.46	0.51		0.46	0.61	1.13	1.65	1.45	0.11	1.34	1.65	1.65	1.00	0.31	0.46	
11	Spray hydraulic application rate	in/mo	1.94	1.88	2.05	1.68	6.55	7.07	7.31	7.31	0.78	1.29	1.95	2.24	**42.04**	2.03	2.43	4.99	7.05	6.41	0.47	5.93	7.31	7.07	4.45	1.31	2.06	**51.51**
12	Effluent Flow	MG/acre-mo	0.05	0.05	0.06	0.05	0.18	0.19	0.20	0.20	0.02	0.03	0.05	0.06	**1.14**	0.06	0.07	0.14	0.19	0.17	0.01	0.16	0.20	0.19	0.12	0.04	0.06	**1.40**
13	Effluent Flow	MG/mo	14.5	14.1	15.3	12.6	49.1	53.0	54.8	54.8	5.8	9.6	14.7	16.8	**315.1**	15.2	18.2	37.4	52.9	48.0	3.5	44.5	54.8	53.0	33.3	9.8	15.4	**386.1**
14																												
15	**Total Nitrogen Application**																											
16	Total nitrogen in spray effluent	mg/L	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0		30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	
17	Total nitrogen in spray effluent	lb/acre-mo	13.2	12.8	13.9	11.4	44.5	48.1	49.7	49.7	5.3	8.7	13.3	15.2	**285.8**	13.8	16.5	33.9	47.9	43.5	3.2	40.3	49.7	48.1	30.2	8.9	14.0	**350.2**
18	Maximum new nitrogen applied this month as fertilizer[2]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	19.2	29.5	0.0	0.0	0.0	0.0	0.0	**48.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.3	0.3	0.0	0.0	0.0	**38.6**
19	Ferilizer nitrogen available [75% cur. mo. + 25% prev. mo.]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	14.4	26.9	7.4	0.0	0.0	0.0	0.0	**48.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.8	9.8	0.1	0.0	0.0	**38.6**
20	Total nitrogen from precip. [line 5 weighted by line 42]	lb/acre-mo	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	**5.0**	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	**5.0**
21	Total nitrogen from fixation [50% of line 30 for legumes]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	15.1	30.2	22.7	7.6	0.0	0.0	**75.6**
22	Total nitrogen applied [line 17 + line 19 + line 20 + line 21]	lb/acre-mo	13.6	13.1	14.4	11.8	44.9	62.9	77.1	57.7	5.7	9.1	13.6	15.7	**339.5**	14.2	16.9	34.4	48.3	43.9	3.6	55.9	109.3	80.9	38.3	9.3	14.4	**469.4**
23																												
24	**Ammonia Application**																											
25	Ammonia in spray effluent	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26	Ammonia in spray effluent	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
27																												
28	**Nitrogen Utilization**																											
29	Crop Name		Cover	Cover	Cover	Corn	Corn	Corn	Corn	Corn	Corn	Barley	Barley	Barley		Barley	Barley	Barley	Barley	Barley	Barley	Soybean	Soybean	Soybean	Soybean	Cover	Cover	
30	Crop Nitrogen Removal	lbs/acre-mo	0.0	0.0	0.0	3.1	23.3	40.3	52.7	32.6	3.1	1.3	2.3	0.7	**159.2**	0.3	2.0	10.4	22.1	22.8	3.3	37.8	75.6	56.7	18.9	0.0	0.0	**249.8**
31	Assumed Denitrification	%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%		15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	
32	Denitrification [line 22 * line 31]	lb/acre-mo	2.04	1.97	2.16	1.77	6.73	9.44	11.56	8.65	0.86	1.37	2.05	2.35	**50.93**	2.13	2.53	5.16	7.25	6.59	0.54	8.39	16.39	12.14	5.74	1.39	2.16	**70.41**
33	Assumed Ammonia Volatilization	%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	
34	Ammonia Volatilization [line 26 * line 33]	lb/acre-mo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
35	Total nitrogen consumed [line 30 + line 32 + line 34]	lb/acre-mo	2.04	1.97	2.16	4.87	29.98	49.74	64.26	41.20	3.96	2.67	4.32	3.00	**210.15**	2.45	4.48	15.56	29.35	29.34	3.79	46.19	91.99	68.84	24.64	1.39	2.16	**320.18**

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
36	**Percolate Nitrogen Content**																											
37	Total nitrogen in percolate [max(line 22 - line 35, 0)]	lb/acre-mo	11.5	11.2	12.2	6.9	14.9	13.2	12.8	16.5	1.7	6.5	9.3	12.7	**129.4**	11.7	12.4	18.8	19.0	14.6	0.0	9.7	17.3	12.1	13.6	7.9	12.2	**149.4**
38	Total nitrogen in percolate	lb/mo	3,184	3,084	3,372	1,906	4,117	3,636	3,535	4,545	482	1,788	2,573	3,494	**35,716**	3,240	3,426	5,194	5,235	4,029	0	2,684	4,773	3,341	3,761	2,175	3,381	**41,240**
39																												
40	**Percolate Volume**																											
41	Spray Hydraulic Application [line 11]	in/mo	1.9	1.9	2.0	1.7	6.5	7.1	7.3	7.3	0.8	1.3	2.0	2.2	**42.0**	2.0	2.4	5.0	7.1	6.4	0.5	5.9	7.3	7.1	4.4	1.3	2.1	**51.5**
42	Climatoligical Normal Precipitation [Exhibit K-K]	in/mo	3.3	3.2	4.1	3.2	3.4	3.6	3.9	5.3	3.6	3.5	3.1	3.6	**43.8**	3.3	3.2	4.1	3.2	3.4	3.6	3.9	5.3	3.6	3.5	3.1	3.6	**43.8**
43	Total Hydraulic Loading [line 41 + line 42]	in/mo	5.2	5.1	6.1	4.9	9.9	10.7	11.2	12.6	4.4	4.8	5.1	5.8	**85.8**	5.3	5.6	9.1	10.3	9.8	4.1	9.8	12.6	10.7	7.9	4.4	5.7	**95.3**
44	Thornwaite Potential Evapotranspiration [Exhibit J-J]	in/mo	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	**27.8**	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	**27.8**
45	Percolate volume [line 43 - line 44]	in/mo	5.1	5.0	5.4	3.1	6.6	5.9	5.7	7.7	0.8	2.9	4.2	5.6	**58.0**	5.2	5.5	8.4	8.5	6.5	0.0	4.3	7.7	7.1	6.0	3.5	5.5	**68.2**
46	Percolate volume	MG/mo	38.5	37.3	40.8	23.1	49.8	44.0	42.8	57.8	5.8	21.6	31.1	42.3	**435.1**	39.2	41.5	62.9	63.4	48.8	0.0	32.5	57.8	53.0	45.3	26.3	40.9	**511.5**
47																												
48	**Percolate Nitrogen Concentration**																											
49	Total nitrogen in percolate [line 38]	lb/mo	3,184	3,084	3,372	1,906	4,117	3,636	3,535	4,545	482	1,788	2,573	3,494	**35,716**	3,240	3,426	5,194	5,235	4,029	0	2,684	4,773	3,341	3,761	2,175	3,381	**41,240**
50	Percolate volume [line 46]	MG/mo	39	37	41	23	50	44	43	58	6	22	31	42	**435**	39	41	63	63	49	0	32	58	53	45	26	41	**512**
51	Total nitrogen concentration in percolate	lb/MG	83	83	83	83	83	83	83	79	83	83	83	83	**987**	83	83	83	83	83	0	83	83	63	83	83	83	**890**
52	**Nitrogen concentration in percolate (Design)**	**mg/L**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.4**	**9.9**	**9.9**	**9.9**	**9.9**		**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**0.0**	**9.9**	**9.9**	**7.6**	**9.9**	**9.9**	**9.9**	
													Design Maximum		**9.9**											Design Maximum		**9.9**

1) This is a user defined field. In general, the two approaches to setting values are either determine the maximum application rate which does not exceed the maximum spray rate or the percolate nitrogen limit (which may represent more volume than is available in the storage lagoon, especially in the summer), or to estimate actual monthly application rates based on available volume and operational preference and confirm that percolate is below the maximum. For design purposes, the maximum application rate methodology was used. These values can be adjusted during operations to explore specific scenarios.

2) This is a user defined field. For design purposes, the values are set as the maximum fertilizer application rate which does not exceed the perolate nitrogen limit, and is calculated after the spray application rate has been determined. Note that if less spray is applied in a given month (such as in the summer months where the design maximum spray exceeds the available volume), the amount of allowable fertilizer would increase. These values can be adjusted during operations to explore specific scenarios. If "Calculate Fertilizer?" is set to FALSE, fertilizer application is set to zero.

Nitrogen Balance Calculations

Facility: ANSRWRF - Phase 1

Field: Field D Crop Areas Without Pivot D-4 (Parcel 2-35-6-11.01)

Scenario: Design 2-Year Cycle, Maximize Monthly Spray, Limit 1.65 in/week

Design Criteria

	Parameter	Units	Value	Notes
1	Crop Management Plan Name	Corn-Wheat-Soybean		*Anticipated typical planting is Corn-Wheat-Soybean, but calculations are done using Corn-Barley-Soybean which is more conservative due to lower TN uptake.
2	Available Wetted Spray Area	(acre)	54.02	
3	Maximum Allowed Spray Rate	(in/week)	2.5	*Maximum 2.5 in/week per regulations, or more restrictive value from Water Balance Calculations.
4	Design Maximum Spray Rate	(in/week)	1.65	*Note: 3/2/2010 Hydrogeological Mounding Model assumed maximum spray of 1.65 in/week for ANSRWRF.
5	Annual Nitrogen from Precipitation	(lb/acre)	5	*Based on National Atmospheric Deposition Program NTN data for Site DE99, 2003-2008.
6	Compute Fertilizer?		TRUE	*If TRUE than fertilizer will be maximized after spray rate is determined. If FALSE then fertilizer will be set to zero.

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
7	Calendar days per month	days/mo	31	28	31	30	31	30	31	31	30	31	30	31	**365**	31	28	31	30	31	30	31	31	30	31	30	31	**365**
8																												
9	**Hydraulic Spray Application**																											
10	Spray hydraulic application rate[1]	in/week	0.44	0.47	0.46	0.39	1.48	1.65	1.65	1.65	0.18	0.29	0.46	0.51		0.46	0.61	1.13	1.65	1.45	0.11	1.34	1.65	1.65	1.00	0.31	0.46	
11	Spray hydraulic application rate	in/mo	1.94	1.88	2.05	1.68	6.55	7.07	7.31	7.31	0.78	1.29	1.95	2.24	**42.04**	2.03	2.43	4.99	7.05	6.41	0.47	5.93	7.31	7.07	4.45	1.31	2.06	**51.51**
12	Effluent Flow	MG/acre-mo	0.05	0.05	0.06	0.05	0.18	0.19	0.20	0.20	0.02	0.03	0.05	0.06	**1.14**	0.06	0.07	0.14	0.19	0.17	0.01	0.16	0.20	0.19	0.12	0.04	0.06	**1.40**
13	Effluent Flow	MG/mo	2.8	2.8	3.0	2.5	9.6	10.4	10.7	10.7	1.1	1.9	2.9	3.3	**61.7**	3.0	3.6	7.3	10.3	9.4	0.7	8.7	10.7	10.4	6.5	1.9	3.0	**75.6**
14																												
15	**Total Nitrogen Application**																											
16	Total nitrogen in spray effluent	mg/L	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0		30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	
17	Total nitrogen in spray effluent	lb/acre-mo	13.2	12.8	13.9	11.4	44.5	48.1	49.7	49.7	5.3	8.7	13.3	15.2	**285.8**	13.8	16.5	33.9	47.9	43.5	3.2	40.3	49.7	48.1	30.2	8.9	14.0	**350.2**
18	Maximum new nitrogen applied this month as fertilizer[2]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	19.2	29.5	0.0	0.0	0.0	0.0	0.0	**48.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.3	0.3	0.0	0.0	0.0	**38.6**
19	Ferilizer nitrogen available [75% cur. mo. + 25% prev. mo.]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	14.4	26.9	7.4	0.0	0.0	0.0	0.0	**48.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.8	9.8	0.1	0.0	0.0	**38.6**
20	Total nitrogen from precip. [line 5 weighted by line 42]	lb/acre-mo	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	**5.0**	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	**5.0**
21	Total nitrogen from fixation [50% of line 30 for legumes]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	15.1	30.2	22.7	7.6	0.0	0.0	**75.6**
22	Total nitrogen applied [line 17 + line 19 + line 20 + line 21]	lb/acre-mo	13.6	13.1	14.4	11.8	44.9	62.9	77.1	57.7	5.7	9.1	13.6	15.7	**339.5**	14.2	16.9	34.4	48.3	43.9	3.6	55.9	109.3	80.9	38.3	9.3	14.4	**469.4**
23																												
24	**Ammonia Application**																											
25	Ammonia in spray effluent	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26	Ammonia in spray effluent	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
27																												
28	**Nitrogen Utilization**																											
29	Crop Name		Cover	Cover	Cover	Corn	Corn	Corn	Corn	Corn	Corn	Barley	Barley	Barley		Barley	Barley	Barley	Barley	Barley	Barley	Soybean	Soybean	Soybean	Soybean	Cover	Cover	
30	Crop Nitrogen Removal	lbs/acre-mo	0.0	0.0	0.0	3.1	23.3	40.3	52.7	32.6	3.1	1.3	2.3	0.7	**159.2**	0.3	2.0	10.4	22.1	22.8	3.3	37.8	75.6	56.7	18.9	0.0	0.0	**249.8**
31	Assumed Denitrification	%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%		15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	
32	Denitrification [line 22 * line 31]	lb/acre-mo	2.04	1.97	2.16	1.77	6.73	9.44	11.56	8.65	0.86	1.37	2.05	2.35	**50.93**	2.13	2.53	5.16	7.25	6.59	0.54	8.39	16.39	12.14	5.74	1.39	2.16	**70.41**
33	Assumed Ammonia Volatilization	%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	
34	Ammonia Volatilization [line 26 * line 33]	lb/acre-mo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
35	Total nitrogen consumed [line 30 + line 32 + line 34]	lb/acre-mo	2.04	1.97	2.16	4.87	29.98	49.74	64.26	41.20	3.96	2.67	4.32	3.00	**210.15**	2.45	4.48	15.56	29.35	29.34	3.79	46.19	91.99	68.84	24.64	1.39	2.16	**320.18**

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
36	**Percolate Nitrogen Content**																											
37	Total nitrogen in percolate [max(line 22 - line 35, 0)]	lb/acre-mo	11.5	11.2	12.2	6.9	14.9	13.2	12.8	16.5	1.7	6.5	9.3	12.7	**129.4**	11.7	12.4	18.8	19.0	14.6	0.0	9.7	17.3	12.1	13.6	7.9	12.2	**149.4**
38	Total nitrogen in percolate	lb/mo	623	603	660	373	806	712	692	889	94	350	504	684	**6,989**	634	670	1,016	1,024	788	0	525	934	654	736	426	662	**8,070**
39																												
40	**Percolate Volume**																											
41	Spray Hydraulic Application [line 11]	in/mo	1.9	1.9	2.0	1.7	6.5	7.1	7.3	7.3	0.8	1.3	2.0	2.2	**42.0**	2.0	2.4	5.0	7.1	6.4	0.5	5.9	7.3	7.1	4.4	1.3	2.1	**51.5**
42	Climatolgical Normal Precipitation [Exhibit K-K]	in/mo	3.3	3.2	4.1	3.2	3.4	3.6	3.9	5.3	3.6	3.5	3.1	3.6	**43.8**	3.3	3.2	4.1	3.2	3.4	3.6	3.9	5.3	3.6	3.5	3.1	3.6	**43.8**
43	Total Hydraulic Loading [line 41 + line 42]	in/mo	5.2	5.1	6.1	4.9	9.9	10.7	11.2	12.6	4.4	4.8	5.1	5.8	**85.8**	5.3	5.6	9.1	10.3	9.8	4.1	9.8	12.6	10.7	7.9	4.4	5.7	**95.3**
44	Thornwaite Potential Evapotranspiration [Exhibit J-J]	in/mo	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	**27.8**	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	**27.8**
45	Percolate volume [line 43 - line 44]	in/mo	5.1	5.0	5.4	3.1	6.6	5.9	5.7	7.7	0.8	2.9	4.2	5.6	**58.0**	5.2	5.5	8.4	8.5	6.5	0.0	4.3	7.7	7.1	6.0	3.5	5.5	**68.2**
46	Percolate volume	MG/mo	7.5	7.3	8.0	4.5	9.8	8.6	8.4	11.3	1.1	4.2	6.1	8.3	**85.1**	7.7	8.1	12.3	12.4	9.5	0.0	6.4	11.3	10.4	8.9	5.2	8.0	**100.1**
47																												
48	**Percolate Nitrogen Concentration**																											
49	Total nitrogen in percolate [line 38]	lb/mo	623	603	660	373	806	712	692	889	94	350	504	684	**6,989**	634	670	1,016	1,024	788	0	525	934	654	736	426	662	**8,070**
50	Percolate volume [line 46]	MG/mo	8	7	8	5	10	9	8	11	1	4	6	8	**85**	8	8	12	12	10	0	6	11	10	9	5	8	**100**
51	Total nitrogen concentration in percolate	lb/MG	83	83	83	83	83	83	83	79	83	83	83	83	**987**	83	83	83	83	83	0	83	83	63	83	83	83	**890**
52	**Nitrogen concentration in percolate (Design)**	**mg/L**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.4**	**9.9**	**9.9**	**9.9**	**9.9**		**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**0.0**	**9.9**	**9.9**	**7.6**	**9.9**	**9.9**	**9.9**		
													Design Maximum		**9.9**											Design Maximum		**9.9**

1) This is a user defined field. In general, the two approaches to setting values are either determine the maximum application rate which does not exceed the maximum spray rate or the percolate nitrogen limit (which may represent more volume than is available in the storage lagoon, especially in the summer), or to estimate actual monthly application rates based on available volume and operational preference and confirm that percolate is below the maximum. For design purposes, the maximum application rate methodology was used. These values can be adjusted during operations to explore specific scenarios.

2) This is a user defined field. For design purposes, the values are set as the maximum fertilizer application rate which does not exceed the perolate nitrogen limit, and is calculated after the spray application rate has been determined. Note that if less spray is applied in a given month (such as in the summer months where the design maximum spray exceeds the available volume), the amount of allowable fertilizer would increase. These values can be adjusted during operations to explore specific scenarios. If "Calculate Fertilizer?" is set to FALSE, fertilizer application is set to zero.

Nitrogen Balance Calculations

Facility: ANSRWRF - Phase 1

Field: Field D Crop Areas With Pivot D-4 (Parcel 2-35-6-11.01)

Scenario: Design 2-Year Cycle, Maximize Monthly Spray, Limit 1.65 in/week

Design Criteria

	Parameter	Units	Value	Notes
1	Crop Management Plan Name	Corn-Wheat-Soybean		*Anticipated typical planting is Corn-Wheat-Soybean, but calculations are done using Corn-Barley-Soybean which is more conservative due to lower TN uptake.
2	Available Wetted Spray Area	(acre)	58.03	
3	Maximum Allowed Spray Rate	(in/week)	2.5	*Maximum 2.5 in/week per regulations, or more restrictive value from Water Balance Calculations.
4	Design Maximum Spray Rate	(in/week)	1.65	*Note: 3/2/2010 Hydrogeological Mounding Model assumed maximum spray of 1.65 in/week for ANSRWRF.
5	Annual Nitrogen from Precipitation	(lb/acre)	5	*Based on National Atmospheric Deposition Program NTN data for Site DE99, 2003-2008.
6	Compute Fertilizer?		TRUE	*If TRUE than fertilizer will be maximized after spray rate is determined. If FALSE then fertilizer will be set to zero.

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
7	Calendar days per month	days/mo	31	28	31	30	31	30	31	31	30	31	30	31	**365**	31	28	31	30	31	30	31	31	30	31	30	31	**365**
8																												
9	**Hydraulic Spray Application**																											
10	Spray hydraulic application rate[1]	in/week	0.44	0.47	0.46	0.39	1.48	1.65	1.65	1.65	0.18	0.29	0.46	0.51		0.46	0.61	1.13	1.65	1.45	0.11	1.34	1.65	1.65	1.00	0.31	0.46	
11	Spray hydraulic application rate	in/mo	1.94	1.88	2.05	1.68	6.55	7.07	7.31	7.31	0.78	1.29	1.95	2.24	**42.04**	2.03	2.43	4.99	7.05	6.41	0.47	5.93	7.31	7.07	4.45	1.31	2.06	**51.51**
12	Effluent Flow	MG/acre-mo	0.05	0.05	0.06	0.05	0.18	0.19	0.20	0.20	0.02	0.03	0.05	0.06	**1.14**	0.06	0.07	0.14	0.19	0.17	0.01	0.16	0.20	0.19	0.12	0.04	0.06	**1.40**
13	Effluent Flow	MG/mo	3.1	3.0	3.2	2.6	10.3	11.1	11.5	11.5	1.2	2.0	3.1	3.5	**66.2**	3.2	3.8	7.9	11.1	10.1	0.7	9.4	11.5	11.1	7.0	2.1	3.2	**81.2**
14																												
15	**Total Nitrogen Application**																											
16	Total nitrogen in spray effluent	mg/L	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0		30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	
17	Total nitrogen in spray effluent	lb/acre-mo	13.2	12.8	13.9	11.4	44.5	48.1	49.7	49.7	5.3	8.7	13.3	15.2	**285.8**	13.8	16.5	33.9	47.9	43.5	3.2	40.3	49.7	48.1	30.2	8.9	14.0	**350.2**
18	Maximum new nitrogen applied this month as fertilizer[2]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	19.2	29.5	0.0	0.0	0.0	0.0	0.0	**48.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.3	0.3	0.0	0.0	0.0	**38.6**
19	Ferilizer nitrogen available [75% cur. mo. + 25% prev. mo.]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	14.4	26.9	7.4	0.0	0.0	0.0	0.0	**48.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.8	9.8	0.1	0.0	0.0	**38.6**
20	Total nitrogen from precip. [line 5 weighted by line 42]	lb/acre-mo	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	**5.0**	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	**5.0**
21	Total nitrogen from fixation [50% of line 30 for legumes]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	15.1	30.2	22.7	7.6	0.0	0.0	**75.6**
22	Total nitrogen applied [line 17 + line 19 + line 20 + line 21]	lb/acre-mo	13.6	13.1	14.4	11.8	44.9	62.9	77.1	57.7	5.7	9.1	13.6	15.7	**339.5**	14.2	16.9	34.4	48.3	43.9	3.6	55.9	109.3	80.9	38.3	9.3	14.4	**469.4**
23																												
24	**Ammonia Application**																											
25	Ammonia in spray effluent	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26	Ammonia in spray effluent	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
27																												
28	**Nitrogen Utilization**																											
29	Crop Name		Cover	Cover	Cover	Corn	Corn	Corn	Corn	Corn	Corn	Barley	Barley	Barley		Barley	Barley	Barley	Barley	Barley	Barley	Soybean	Soybean	Soybean	Soybean	Cover	Cover	
30	Crop Nitrogen Removal	lbs/acre-mo	0.0	0.0	0.0	3.1	23.3	40.3	52.7	32.6	3.1	1.3	2.3	0.7	**159.2**	0.3	2.0	10.4	22.1	22.8	3.3	37.8	75.6	56.7	18.9	0.0	0.0	**249.8**
31	Assumed Denitrification	%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%		15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	
32	Denitrification [line 22 * line 31]	lb/acre-mo	2.04	1.97	2.16	1.77	6.73	9.44	11.56	8.65	0.86	1.37	2.05	2.35	**50.93**	2.13	2.53	5.16	7.25	6.59	0.54	8.39	16.39	12.14	5.74	1.39	2.16	**70.41**
33	Assumed Ammonia Volatilization	%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	
34	Ammonia Volatilization [line 26 * line 33]	lb/acre-mo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
35	Total nitrogen consumed [line 30 + line 32 + line 34]	lb/acre-mo	2.04	1.97	2.16	4.87	29.98	49.74	64.26	41.20	3.96	2.67	4.32	3.00	**210.15**	2.45	4.48	15.56	29.35	29.34	3.79	46.19	91.99	68.84	24.64	1.39	2.16	**320.18**

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
36	**Percolate Nitrogen Content**																											
37	Total nitrogen in percolate [max(line 22 - line 35, 0)]	lb/acre-mo	11.5	11.2	12.2	6.9	14.9	13.2	12.8	16.5	1.7	6.5	9.3	12.7	**129.4**	11.7	12.4	18.8	19.0	14.6	0.0	9.7	17.3	12.1	13.6	7.9	12.2	**149.4**
38	Total nitrogen in percolate	lb/mo	669	648	709	401	865	764	743	955	101	376	541	735	**7,508**	681	720	1,092	1,100	847	0	564	1,003	702	791	457	711	**8,669**
39																												
40	**Percolate Volume**																											
41	Spray Hydraulic Application [line 11]	in/mo	1.9	1.9	2.0	1.7	6.5	7.1	7.3	7.3	0.8	1.3	2.0	2.2	**42.0**	2.0	2.4	5.0	7.1	6.4	0.5	5.9	7.3	7.1	4.4	1.3	2.1	**51.5**
42	Climatolgical Normal Precipitation [Exhibit K-K]	in/mo	3.3	3.2	4.1	3.2	3.4	3.6	3.9	5.3	3.6	3.5	3.1	3.6	**43.8**	3.3	3.2	4.1	3.2	3.4	3.6	3.9	5.3	3.6	3.5	3.1	3.6	**43.8**
43	Total Hydraulic Loading [line 41 + line 42]	in/mo	5.2	5.1	6.1	4.9	9.9	10.7	11.2	12.6	4.4	4.8	5.1	5.8	**85.8**	5.3	5.6	9.1	10.3	9.8	4.1	9.8	12.6	10.7	7.9	4.4	5.7	**95.3**
44	Thornwaite Potential Evapotranspiration [Exhibit J-J]	in/mo	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	**27.8**	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	**27.8**
45	Percolate volume [line 43 - line 44]	in/mo	5.1	5.0	5.4	3.1	6.6	5.9	5.7	7.7	0.8	2.9	4.2	5.6	**58.0**	5.2	5.5	8.4	8.5	6.5	0.0	4.3	7.7	7.1	6.0	3.5	5.5	**68.2**
46	Percolate volume	MG/mo	8.1	7.8	8.6	4.8	10.5	9.3	9.0	12.1	1.2	4.5	6.5	8.9	**91.5**	8.2	8.7	13.2	13.3	10.3	0.0	6.8	12.1	11.1	9.5	5.5	8.6	**107.5**
47																												
48	**Percolate Nitrogen Concentration**																											
49	Total nitrogen in percolate [line 38]	lb/mo	669	648	709	401	865	764	743	955	101	376	541	735	**7,508**	681	720	1,092	1,100	847	0	564	1,003	702	791	457	711	**8,669**
50	Percolate volume [line 46]	MG/mo	8	8	9	5	10	9	9	12	1	5	7	9	**91**	8	9	13	13	10	0	7	12	11	10	6	9	**108**
51	Total nitrogen concentration in percolate	lb/MG	83	83	83	83	83	83	83	79	83	83	83	83	**987**	83	83	83	83	83	0	83	83	63	83	83	83	**890**
52	**Nitrogen concentration in percolate (Design)**	**mg/L**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.4**	**9.9**	**9.9**	**9.9**	**9.9**		**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**0.0**	**9.9**	**9.9**	**7.6**	**9.9**	**9.9**	**9.9**		
													Design Maximum		**9.9**											Design Maximum		**9.9**

1) This is a user defined field. In general, the two approaches to setting values are either determine the maximum application rate which does not exceed the maximum spray rate or the percolate nitrogen limit (which may represent more volume than is available in the storage lagoon, especially in the summer), or to estimate actual monthly application rates based on available volume and operational preference and confirm that percolate is below the maximum. For design purposes, the maximum application rate methodology was used. These values can be adjusted during operations to explore specific scenarios.

2) This is a user defined field. For design purposes, the values are set as the maximum fertilizer application rate which does not exceed the perolate nitrogen limit, and is calculated after the spray application rate has been determined. Note that if less spray is applied in a given month (such as in the summer months where the design maximum spray exceeds the available volume), the amount of allowable fertilizer would increase. These values can be adjusted during operations to explore specific scenarios. If "Calculate Fertilizer?" is set to FALSE, fertilizer application is set to zero.

Nitrogen Balance Calculations

Facility: ANSRWRF - Phase 1

Field: Field E Crop Areas

Scenario: Design 2-Year Cycle, Maximize Monthly Spray, Limit 1.65 in/week

Design Criteria

	Parameter	Units	Value	Notes
1	Crop Management Plan Name	Corn-Wheat-Soybean		*Anticipated typical planting is Corn-Wheat-Soybean, but calculations are done using Corn-Barley-Soybean which is more conservative due to lower TN uptake.
2	Available Wetted Spray Area	(acre)	90.48	
3	Maximum Allowed Spray Rate	(in/week)	2.5	*Maximum 2.5 in/week per regulations, or more restrictive value from Water Balance Calculations.
4	Design Maximum Spray Rate	(in/week)	1.65	*Note: 3/2/2010 Hydrogeological Mounding Model assumed maximum spray of 1.65 in/week for ANSRWRF.
5	Annual Nitrogen from Precipitation	(lb/acre)	5	*Based on National Atmospheric Deposition Program NTN data for Site DE99, 2003-2008.
6	Compute Fertilizer?		TRUE	*If TRUE than fertilizer will be maximized after spray rate is determined. If FALSE then fertilizer will be set to zero.

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
7	Calendar days per month	days/mo	31	28	31	30	31	30	31	31	30	31	30	31	**365**	31	28	31	30	31	30	31	31	30	31	30	31	**365**
8																												
9	**Hydraulic Spray Application**																											
10	Spray hydraulic application rate[1]	in/week	0.44	0.47	0.46	0.39	1.48	1.65	1.65	1.65	0.18	0.29	0.46	0.51		0.46	0.61	1.13	1.65	1.45	0.11	1.34	1.65	1.65	1.00	0.31	0.46	
11	Spray hydraulic application rate	in/mo	1.94	1.88	2.05	1.68	6.55	7.07	7.31	7.31	0.78	1.29	1.95	2.24	**42.04**	2.03	2.43	4.99	7.05	6.41	0.47	5.93	7.31	7.07	4.45	1.31	2.06	**51.51**
12	Effluent Flow	MG/acre-mo	0.05	0.05	0.06	0.05	0.18	0.19	0.20	0.20	0.02	0.03	0.05	0.06	**1.14**	0.06	0.07	0.14	0.19	0.17	0.01	0.16	0.20	0.19	0.12	0.04	0.06	**1.40**
13	Effluent Flow	MG/mo	4.8	4.6	5.0	4.1	16.1	17.4	18.0	18.0	1.9	3.2	4.8	5.5	**103.3**	5.0	6.0	12.3	17.3	15.7	1.2	14.6	18.0	17.4	10.9	3.2	5.1	**126.6**
14																												
15	**Total Nitrogen Application**																											
16	Total nitrogen in spray effluent	mg/L	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0		30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	
17	Total nitrogen in spray effluent	lb/acre-mo	13.2	12.8	13.9	11.4	44.5	48.1	49.7	49.7	5.3	8.7	13.3	15.2	**285.8**	13.8	16.5	33.9	47.9	43.5	3.2	40.3	49.7	48.1	30.2	8.9	14.0	**350.2**
18	Maximum new nitrogen applied this month as fertilizer[2]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	19.2	29.5	0.0	0.0	0.0	0.0	0.0	**48.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.3	0.3	0.0	0.0	0.0	**38.6**
19	Ferilizer nitrogen available [75% cur. mo. + 25% prev. mo.]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	14.4	26.9	7.4	0.0	0.0	0.0	0.0	**48.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.8	9.8	0.1	0.0	0.0	**38.6**
20	Total nitrogen from precip. [line 5 weighted by line 42]	lb/acre-mo	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	**5.0**	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	**5.0**
21	Total nitrogen from fixation [50% of line 30 for legumes]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	15.1	30.2	22.7	7.6	0.0	0.0	**75.6**
22	Total nitrogen applied [line 17 + line 19 + line 20 + line 21]	lb/acre-mo	13.6	13.1	14.4	11.8	44.9	62.9	77.1	57.7	5.7	9.1	13.6	15.7	**339.5**	14.2	16.9	34.4	48.3	43.9	3.6	55.9	109.3	80.9	38.3	9.3	14.4	**469.4**
23																												
24	**Ammonia Application**																											
25	Ammonia in spray effluent	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26	Ammonia in spray effluent	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
27																												
28	**Nitrogen Utilization**																											
29	Crop Name		Cover	Cover	Cover	Corn	Corn	Corn	Corn	Corn	Corn	Barley	Barley	Barley		Barley	Barley	Barley	Barley	Barley	Barley	Soybean	Soybean	Soybean	Soybean	Cover	Cover	
30	Crop Nitrogen Removal	lbs/acre-mo	0.0	0.0	0.0	3.1	23.3	40.3	52.7	32.6	3.1	1.3	2.3	0.7	**159.2**	0.3	2.0	10.4	22.1	22.8	3.3	37.8	75.6	56.7	18.9	0.0	0.0	**249.8**
31	Assumed Denitrification	%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%		15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	
32	Denitrification [line 22 * line 31]	lb/acre-mo	2.04	1.97	2.16	1.77	6.73	9.44	11.56	8.65	0.86	1.37	2.05	2.35	**50.93**	2.13	2.53	5.16	7.25	6.59	0.54	8.39	16.39	12.14	5.74	1.39	2.16	**70.41**
33	Assumed Ammonia Volatilization	%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	
34	Ammonia Volatilization [line 26 * line 33]	lb/acre-mo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
35	Total nitrogen consumed [line 30 + line 32 + line 34]	lb/acre-mo	2.04	1.97	2.16	4.87	29.98	49.74	64.26	41.20	3.96	2.67	4.32	3.00	**210.15**	2.45	4.48	15.56	29.35	29.34	3.79	46.19	91.99	68.84	24.64	1.39	2.16	**320.18**

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
36	**Percolate Nitrogen Content**																											
37	Total nitrogen in percolate [max(line 22 - line 35, 0)]	lb/acre-mo	11.5	11.2	12.2	6.9	14.9	13.2	12.8	16.5	1.7	6.5	9.3	12.7	**129.4**	11.7	12.4	18.8	19.0	14.6	0.0	9.7	17.3	12.1	13.6	7.9	12.2	**149.4**
38	Total nitrogen in percolate	lb/mo	1,043	1,011	1,105	625	1,349	1,192	1,158	1,489	158	586	843	1,145	**11,706**	1,062	1,123	1,702	1,716	1,321	0	880	1,564	1,095	1,233	713	1,108	**13,517**
39																												
40	**Percolate Volume**																											
41	Spray Hydraulic Application [line 11]	in/mo	1.9	1.9	2.0	1.7	6.5	7.1	7.3	7.3	0.8	1.3	2.0	2.2	**42.0**	2.0	2.4	5.0	7.1	6.4	0.5	5.9	7.3	7.1	4.4	1.3	2.1	**51.5**
42	Climatolgical Normal Precipitation [Exhibit K-K]	in/mo	3.3	3.2	4.1	3.2	3.4	3.6	3.9	5.3	3.6	3.5	3.1	3.6	**43.8**	3.3	3.2	4.1	3.2	3.4	3.6	3.9	5.3	3.6	3.5	3.1	3.6	**43.8**
43	Total Hydraulic Loading [line 41 + line 42]	in/mo	5.2	5.1	6.1	4.9	9.9	10.7	11.2	12.6	4.4	4.8	5.1	5.8	**85.8**	5.3	5.6	9.1	10.3	9.8	4.1	9.8	12.6	10.7	7.9	4.4	5.7	**95.3**
44	Thornwaite Potential Evapotranspiration [Exhibit J-J]	in/mo	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	**27.8**	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	**27.8**
45	Percolate volume [line 43 - line 44]	in/mo	5.1	5.0	5.4	3.1	6.6	5.9	5.7	7.7	0.8	2.9	4.2	5.6	**58.0**	5.2	5.5	8.4	8.5	6.5	0.0	4.3	7.7	7.1	6.0	3.5	5.5	**68.2**
46	Percolate volume	MG/mo	12.6	12.2	13.4	7.6	16.3	14.4	14.0	18.9	1.9	7.1	10.2	13.9	**142.6**	12.9	13.6	20.6	20.8	16.0	0.0	10.6	18.9	17.4	14.9	8.6	13.4	**167.7**
47																												
48	**Percolate Nitrogen Concentration**																											
49	Total nitrogen in percolate [line 38]	lb/mo	1,043	1,011	1,105	625	1,349	1,192	1,158	1,489	158	586	843	1,145	**11,706**	1,062	1,123	1,702	1,716	1,321	0	880	1,564	1,095	1,233	713	1,108	**13,517**
50	Percolate volume [line 46]	MG/mo	13	12	13	8	16	14	14	19	2	7	10	14	**143**	13	14	21	21	16	0	11	19	17	15	9	13	**168**
51	Total nitrogen concentration in percolate	lb/MG	83	83	83	83	83	83	83	79	83	83	83	83	**987**	83	83	83	83	83	0	83	83	63	83	83	83	**890**
52	**Nitrogen concentration in percolate (Design)**	**mg/L**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.4**	**9.9**	**9.9**	**9.9**	**9.9**		**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**0.0**	**9.9**	**9.9**	**7.6**	**9.9**	**9.9**	**9.9**	
													Design Maximum		**9.9**											Design Maximum		**9.9**

1) This is a user defined field. In general, the two approaches to setting values are either determine the maximum application rate which does not exceed the maximum spray rate or the percolate nitrogen limit (which may represent more volume than is available in the storage lagoon, especially in the summer), or to estimate actual monthly application rates based on available volume and operational preference and confirm that percolate is below the maximum. For design purposes, the maximum application rate methodology was used. These values can be adjusted during operations to explore specific scenarios.

2) This is a user defined field. For design purposes, the values are set as the maximum fertilizer application rate which does not exceed the perolate nitrogen limit, and is calculated after the spray application rate has been determined. Note that if less spray is applied in a given month (such as in the summer months where the design maximum spray exceeds the available volume), the amount of allowable fertilizer would increase. These values can be adjusted during operations to explore specific scenarios. If "Calculate Fertilizer?" is set to FALSE, fertilizer application is set to zero.

Nitrogen Balance Calculations

Facility: ANSRWRF - Phase 1

Field: Field F Crop Areas

Scenario: Design 2-Year Cycle, Maximize Monthly Spray, Limit 1.65 in/week

Design Criteria

	Parameter	Units	Value	Notes
1	Crop Management Plan Name		Corn-Wheat-Soybean	*Anticipated typical planting is Corn-Wheat-Soybean, but calculations are done using Corn-Barley-Soybean which is more conservative due to lower TN uptake.
2	Available Wetted Spray Area	(acre)	110.48	
3	Maximum Allowed Spray Rate	(in/week)	2.5	*Maximum 2.5 in/week per regulations, or more restrictive value from Water Balance Calculations.
4	Design Maximum Spray Rate	(in/week)	1.65	*Note: 3/2/2010 Hydrogeological Mounding Model assumed maximum spray of 1.65 in/week for ANSRWRF.
5	Annual Nitrogen from Precipitation	(lb/acre)	5	*Based on National Atmospheric Deposition Program NTN data for Site DE99, 2003-2008.
6	Compute Fertilizer?		TRUE	*If TRUE than fertilizer will be maximized after spray rate is determined. If FALSE then fertilizer will be set to zero.

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
7	Calendar days per month	days/mo	31	28	31	30	31	30	31	31	30	31	30	31	**365**	31	28	31	30	31	30	31	31	30	31	30	31	**365**
8																												
9	**Hydraulic Spray Application**																											
10	Spray hydraulic application rate[1]	in/week	0.44	0.47	0.46	0.39	1.48	1.65	1.65	1.65	0.18	0.29	0.46	0.51		0.46	0.61	1.13	1.65	1.45	0.11	1.34	1.65	1.65	1.00	0.31	0.46	
11	Spray hydraulic application rate	in/mo	1.94	1.88	2.05	1.68	6.55	7.07	7.31	7.31	0.78	1.29	1.95	2.24	**42.04**	2.03	2.43	4.99	7.05	6.41	0.47	5.93	7.31	7.07	4.45	1.31	2.06	**51.51**
12	Effluent Flow	MG/acre-mo	0.05	0.05	0.06	0.05	0.18	0.19	0.20	0.20	0.02	0.03	0.05	0.06	**1.14**	0.06	0.07	0.14	0.19	0.17	0.01	0.16	0.20	0.19	0.12	0.04	0.06	**1.40**
13	Effluent Flow	MG/mo	5.8	5.6	6.1	5.0	19.6	21.2	21.9	21.9	2.3	3.9	5.9	6.7	**126.1**	6.1	7.3	15.0	21.2	19.2	1.4	17.8	21.9	21.2	13.3	3.9	6.2	**154.5**
14																												
15	**Total Nitrogen Application**																											
16	Total nitrogen in spray effluent	mg/L	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0		30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	
17	Total nitrogen in spray effluent	lb/acre-mo	13.2	12.8	13.9	11.4	44.5	48.1	49.7	49.7	5.3	8.7	13.3	15.2	**285.8**	13.8	16.5	33.9	47.9	43.5	3.2	40.3	49.7	48.1	30.2	8.9	14.0	**350.2**
18	Maximum new nitrogen applied this month as fertilizer[2]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	19.2	29.5	0.0	0.0	0.0	0.0	0.0	**48.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.3	0.3	0.0	0.0	0.0	**38.6**
19	Ferilizer nitrogen available [75% cur. mo. + 25% prev. mo.]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	14.4	26.9	7.4	0.0	0.0	0.0	0.0	**48.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.8	9.8	0.1	0.0	0.0	**38.6**
20	Total nitrogen from precip. [line 5 weighted by line 42]	lb/acre-mo	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	**5.0**	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	**5.0**
21	Total nitrogen from fixation [50% of line 30 for legumes]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	15.1	30.2	22.7	7.6	0.0	0.0	**75.6**
22	Total nitrogen applied [line 17 + line 19 + line 20 + line 21]	lb/acre-mo	13.6	13.1	14.4	11.8	44.9	62.9	77.1	57.7	5.7	9.1	13.6	15.7	**339.5**	14.2	16.9	34.4	48.3	43.9	3.6	55.9	109.3	80.9	38.3	9.3	14.4	**469.4**
23																												
24	**Ammonia Application**																											
25	Ammonia in spray effluent	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26	Ammonia in spray effluent	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
27																												
28	**Nitrogen Utilization**																											
29	Crop Name		Cover	Cover	Cover	Corn	Corn	Corn	Corn	Corn	Corn	Barley	Barley	Barley		Barley	Barley	Barley	Barley	Barley	Barley	Soybean	Soybean	Soybean	Soybean	Cover	Cover	
30	Crop Nitrogen Removal	lbs/acre-mo	0.0	0.0	0.0	3.1	23.3	40.3	52.7	32.6	3.1	1.3	2.3	0.7	**159.2**	0.3	2.0	10.4	22.1	22.8	3.3	37.8	75.6	56.7	18.9	0.0	0.0	**249.8**
31	Assumed Denitrification	%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%		15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	
32	Denitrification [line 22 * line 31]	lb/acre-mo	2.04	1.97	2.16	1.77	6.73	9.44	11.56	8.65	0.86	1.37	2.05	2.35	**50.93**	2.13	2.53	5.16	7.25	6.59	0.54	8.39	16.39	12.14	5.74	1.39	2.16	**70.41**
33	Assumed Ammonia Volatilization	%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	
34	Ammonia Volatilization [line 26 * line 33]	lb/acre-mo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
35	Total nitrogen consumed [line 30 + line 32 + line 34]	lb/acre-mo	2.04	1.97	2.16	4.87	29.98	49.74	64.26	41.20	3.96	2.67	4.32	3.00	**210.15**	2.45	4.48	15.56	29.35	29.34	3.79	46.19	91.99	68.84	24.64	1.39	2.16	**320.18**

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
36	**Percolate Nitrogen Content**																											
37	Total nitrogen in percolate [max(line 22 - line 35, 0)]	lb/acre-mo	11.5	11.2	12.2	6.9	14.9	13.2	12.8	16.5	1.7	6.5	9.3	12.7	**129.4**	11.7	12.4	18.8	19.0	14.6	0.0	9.7	17.3	12.1	13.6	7.9	12.2	**149.4**
38	Total nitrogen in percolate	lb/mo	1,274	1,234	1,350	763	1,648	1,455	1,415	1,819	193	716	1,030	1,398	**14,293**	1,297	1,371	2,079	2,095	1,613	0	1,074	1,910	1,337	1,505	870	1,353	**16,504**
39																												
40	**Percolate Volume**																											
41	Spray Hydraulic Application [line 11]	in/mo	1.9	1.9	2.0	1.7	6.5	7.1	7.3	7.3	0.8	1.3	2.0	2.2	**42.0**	2.0	2.4	5.0	7.1	6.4	0.5	5.9	7.3	7.1	4.4	1.3	2.1	**51.5**
42	Climatolgical Normal Precipitation [Exhibit K-K]	in/mo	3.3	3.2	4.1	3.2	3.4	3.6	3.9	5.3	3.6	3.5	3.1	3.6	**43.8**	3.3	3.2	4.1	3.2	3.4	3.6	3.9	5.3	3.6	3.5	3.1	3.6	**43.8**
43	Total Hydraulic Loading [line 41 + line 42]	in/mo	5.2	5.1	6.1	4.9	9.9	10.7	11.2	12.6	4.4	4.8	5.1	5.8	**85.8**	5.3	5.6	9.1	10.3	9.8	4.1	9.8	12.6	10.7	7.9	4.4	5.7	**95.3**
44	Thornwaite Potential Evapotranspiration [Exhibit J-J]	in/mo	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	**27.8**	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	**27.8**
45	Percolate volume [line 43 - line 44]	in/mo	5.1	5.0	5.4	3.1	6.6	5.9	5.7	7.7	0.8	2.9	4.2	5.6	**58.0**	5.2	5.5	8.4	8.5	6.5	0.0	4.3	7.7	7.1	6.0	3.5	5.5	**68.2**
46	Percolate volume	MG/mo	15.4	14.9	16.3	9.2	19.9	17.6	17.1	23.1	2.3	8.7	12.5	16.9	**174.1**	15.7	16.6	25.2	25.4	19.5	0.0	13.0	23.1	21.2	18.1	10.5	16.4	**204.7**
47																												
48	**Percolate Nitrogen Concentration**																											
49	Total nitrogen in percolate [line 38]	lb/mo	1,274	1,234	1,350	763	1,648	1,455	1,415	1,819	193	716	1,030	1,398	**14,293**	1,297	1,371	2,079	2,095	1,613	0	1,074	1,910	1,337	1,505	870	1,353	**16,504**
50	Percolate volume [line 46]	MG/mo	15	15	16	9	20	18	17	23	2	9	12	17	**174**	16	17	25	25	20	0	13	23	21	18	11	16	**205**
51	Total nitrogen concentration in percolate	lb/MG	83	83	83	83	83	83	83	79	83	83	83	83	**987**	83	83	83	83	83	0	83	83	63	83	83	83	**890**
52	**Nitrogen concentration in percolate (Design)**	**mg/L**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.4**	**9.9**	**9.9**	**9.9**	**9.9**		**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**0.0**	**9.9**	**9.9**	**7.6**	**9.9**	**9.9**	**9.9**	
													Design Maximum		**9.9**											Design Maximum		**9.9**

1) This is a user defined field. In general, the two approaches to setting values are either determine the maximum application rate which does not exceed the maximum spray rate or the percolate nitrogen limit (which may represent more volume than is available in the storage lagoon, especially in the summer), or to estimate actual monthly application rates based on available volume and operational preference and confirm that percolate is below the maximum. For design purposes, the maximum application rate methodology was used. These values can be adjusted during operations to explore specific scenarios.

2) This is a user defined field. For design purposes, the values are set as the maximum fertilizer application rate which does not exceed the perolate nitrogen limit, and is calculated after the spray application rate has been determined. Note that if less spray is applied in a given month (such as in the summer months where the design maximum spray exceeds the available volume), the amount of allowable fertilizer would increase. These values can be adjusted during operations to explore specific scenarios. If "Calculate Fertilizer?" is set to FALSE, fertilizer application is set to zero.

Nitrogen Balance Calculations

Facility: ANSRWRF - Phase 1

Field: Field G Wood Areas

Scenario: Design 2-Year Cycle, Maximize Monthly Spray, Limit 1.65 in/week

Design Criteria

	Parameter	Units	Value	Notes
1	Crop Management Plan Name		Loblolly Pine Woods	
2	Available Wetted Spray Area	(acre)	200.47	
3	Maximum Allowed Spray Rate	(in/week)	2.5	*Maximum 2.5 in/week per regulations, or more restrictive value from Water Balance Calculations.
4	Design Maximum Spray Rate	(in/week)	1.65	*Note: 3/2/2010 Hydrogeological Mounding Model assumed maximum spray of 1.65 in/week for ANSRWRF.
5	Annual Nitrogen from Precipitation	(lb/acre)	5	*Based on National Atmospheric Deposition Program NTN data for Site DE99, 2003-2008.
6	Compute Fertilizer?		FALSE	*If TRUE than fertilizer will be maximized after spray rate is determined. If FALSE then fertilizer will be set to zero.

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
7	Calendar days per month	days/mo	31	28	31	30	31	30	31	31	30	31	30	31	**365**	31	28	31	30	31	30	31	31	30	31	30	31	**365**
8																												
9	**Hydraulic Spray Application**																											
10	Spray hydraulic application rate[1]	in/week	0.90	0.76	0.87	0.92	0.96	1.42	1.65	1.65	1.65	1.51	1.27	1.14		0.90	0.76	0.87	0.92	0.96	1.42	1.65	1.65	1.65	1.51	1.27	1.14	
11	Spray hydraulic application rate	in/mo	4.00	3.04	3.86	3.94	4.26	6.08	7.30	7.31	7.07	6.70	5.44	5.03	**64.04**	4.00	3.04	3.86	3.94	4.26	6.08	7.30	7.31	7.07	6.70	5.44	5.03	**64.04**
12	Effluent Flow	MG/acre-mo	0.11	0.08	0.10	0.11	0.12	0.17	0.20	0.20	0.19	0.18	0.15	0.14	**1.74**	0.11	0.08	0.10	0.11	0.12	0.17	0.20	0.20	0.19	0.18	0.15	0.14	**1.74**
13	Effluent Flow	MG/mo	21.8	16.5	21.0	21.4	23.2	33.1	39.7	39.8	38.5	36.5	29.6	27.4	**348.6**	21.8	16.5	21.0	21.4	23.2	33.1	39.7	39.8	38.5	36.5	29.6	27.4	**348.6**
14																												
15	**Total Nitrogen Application**																											
16	Total nitrogen in spray effluent	mg/L	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0		30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	
17	Total nitrogen in spray effluent	lb/acre-mo	27.2	20.6	26.3	26.8	29.0	41.3	49.6	49.7	48.1	45.6	37.0	34.2	**435.4**	27.2	20.6	26.3	26.8	29.0	41.3	49.6	49.7	48.1	45.6	37.0	34.2	**435.4**
18	Maximum new nitrogen applied this month as fertilizer[2]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
19	Ferilizer nitrogen available [75% cur. mo. + 25% prev. mo.]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
20	Total nitrogen from precip. [line 5 weighted by line 42]	lb/acre-mo	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	**5.0**	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	**5.0**
21	Total nitrogen from fixation [50% of line 30 for legumes]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
22	Total nitrogen applied [line 17 + line 19 + line 20 + line 21]	lb/acre-mo	27.6	21.0	26.7	27.1	29.4	41.7	50.1	50.3	48.5	46.0	37.3	34.6	**440.4**	27.6	21.0	26.7	27.1	29.4	41.7	50.1	50.3	48.5	46.0	37.3	34.6	**440.4**
23																												
24	**Ammonia Application**																											
25	Ammonia in spray effluent	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26	Ammonia in spray effluent	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
27																												
28	**Nitrogen Utilization**																											
29	Crop Name		LP	LP	LP	LP	LP	LP	LP	LP	LP	LP	LP	LP		LP	LP	LP	LP	LP	LP	LP	LP	LP	LP	LP	LP	
30	Crop Nitrogen Removal	lbs/acre-mo	7.3	4.1	6.4	11.1	15.2	24.5	29.8	29.8	26.3	20.4	14.6	10.5	**200.0**	7.3	4.1	6.4	11.1	15.2	24.5	29.8	29.8	26.3	20.4	14.6	10.5	**200.0**
31	Assumed Denitrification	%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%		15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	
32	Denitrification [line 22 * line 31]	lb/acre-mo	4.14	3.15	4.01	4.07	4.41	6.26	7.51	7.54	7.27	6.89	5.60	5.19	**66.05**	4.14	3.15	4.01	4.07	4.41	6.26	7.51	7.54	7.27	6.89	5.60	5.19	**66.05**
33	Assumed Ammonia Volatilization	%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	
34	Ammonia Volatilization [line 26 * line 33]	lb/acre-mo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
35	Total nitrogen consumed [line 30 + line 32 + line 34]	lb/acre-mo	11.44	7.24	10.43	15.17	19.59	30.78	37.29	37.32	33.55	27.33	20.20	15.70	**266.05**	11.44	7.24	10.43	15.17	19.59	30.78	37.29	37.32	33.55	27.33	20.20	15.70	**266.05**

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
36	**Percolate Nitrogen Content**																											
37	Total nitrogen in percolate [max(line 22 - line 35, 0)]	lb/acre-mo	16.2	13.8	16.3	12.0	9.8	10.9	12.8	13.0	14.9	18.6	17.1	18.9	**174.3**	16.2	13.8	16.3	12.0	9.8	10.9	12.8	13.0	14.9	18.6	17.1	18.9	**174.3**
38	Total nitrogen in percolate	lb/mo	3,240	2,760	3,266	2,401	1,963	2,194	2,564	2,598	2,994	3,733	3,437	3,792	**34,943**	3,240	2,760	3,266	2,401	1,963	2,194	2,564	2,598	2,994	3,733	3,437	3,792	**34,943**
39																												
40	**Percolate Volume**																											
41	Spray Hydraulic Application [line 11]	in/mo	4.0	3.0	3.9	3.9	4.3	6.1	7.3	7.3	7.1	6.7	5.4	5.0	**64.0**	4.0	3.0	3.9	3.9	4.3	6.1	7.3	7.3	7.1	6.7	5.4	5.0	**64.0**
42	Climatolgical Normal Precipitation [Exhibit K-K]	in/mo	3.3	3.2	4.1	3.2	3.4	3.6	3.9	5.3	3.6	3.5	3.1	3.6	**43.8**	3.3	3.2	4.1	3.2	3.4	3.6	3.9	5.3	3.6	3.5	3.1	3.6	**43.8**
43	Total Hydraulic Loading [line 41 + line 42]	in/mo	7.3	6.2	8.0	7.1	7.7	9.7	11.2	12.6	10.7	10.2	8.5	8.6	**107.8**	7.3	6.2	8.0	7.1	7.7	9.7	11.2	12.6	10.7	10.2	8.5	8.6	**107.8**
44	Thornwaite Potential Evapotranspiration [Exhibit J-J]	in/mo	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	**27.8**	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	**27.8**
45	Percolate volume [line 43 - line 44]	in/mo	7.2	6.1	7.3	5.3	4.4	4.9	5.7	7.7	7.1	8.3	7.6	8.4	**80.0**	7.2	6.1	7.3	5.3	4.4	4.9	5.7	7.7	7.1	8.3	7.6	8.4	**80.0**
46	Percolate volume	MG/mo	39.2	33.4	39.5	29.1	23.8	26.5	31.0	42.0	38.5	45.2	41.6	45.9	**435.7**	39.2	33.4	39.5	29.1	23.8	26.5	31.0	42.0	38.5	45.2	41.6	45.9	**435.7**
47																												
48	**Percolate Nitrogen Concentration**																											
49	Total nitrogen in percolate [line 38]	lb/mo	3,240	2,760	3,266	2,401	1,963	2,194	2,564	2,598	2,994	3,733	3,437	3,792	**34,943**	3,240	2,760	3,266	2,401	1,963	2,194	2,564	2,598	2,994	3,733	3,437	3,792	**34,943**
50	Percolate volume [line 46]	MG/mo	39	33	40	29	24	27	31	42	38	45	42	46	**436**	39	33	40	29	24	27	31	42	38	45	42	46	**436**
51	Total nitrogen concentration in percolate	lb/MG	83	83	83	83	83	83	83	62	78	83	83	83	**966**	83	83	83	83	83	83	83	62	78	83	83	83	**966**
52	**Nitrogen concentration in percolate (Design)**	**mg/L**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**7.4**	**9.3**	**9.9**	**9.9**	**9.9**		**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**7.4**	**9.3**	**9.9**	**9.9**	**9.9**	
													Design Maximum		**9.9**											Design Maximum		**9.9**

1) This is a user defined field. In general, the two approaches to setting values are either determine the maximum application rate which does not exceed the maximum spray rate or the percolate nitrogen limit (which may represent more volume than is available in the storage lagoon, especially in the summer), or to estimate actual monthly application rates based on available volume and operational preference and confirm that percolate is below the maximum. For design purposes, the maximum application rate methodology was used. These values can be adjusted during operations to explore specific scenarios.

2) This is a user defined field. For design purposes, the values are set as the maximum fertilizer application rate which does not exceed the perolate nitrogen limit, and is calculated after the spray application rate has been determined. Note that if less spray is applied in a given month (such as in the summer months where the design maximum spray exceeds the available volume), the amount of allowable fertilizer would increase. These values can be adjusted during operations to explore specific scenarios. If "Calculate Fertilizer?" is set to FALSE, fertilizer application is set to zero.

Nitrogen Balance Calculations

Facility: ANSRWRF - Phase 1

Field: Field D Wood Areas

Scenario: Design 2-Year Cycle, Maximize Monthly Spray, Limit 1.65 in/week

Design Criteria

	Parameter	Units	Value	Notes
1	Crop Management Plan Name		Loblolly Pine Woods	
2	Available Wetted Spray Area	(acre)	32.69	
3	Maximum Allowed Spray Rate	(in/week)	2.5	*Maximum 2.5 in/week per regulations, or more restrictive value from Water Balance Calculations.
4	Design Maximum Spray Rate	(in/week)	1.65	*Note: 3/2/2010 Hydrogeological Mounding Model assumed maximum spray of 1.65 in/week for ANSRWRF.
5	Annual Nitrogen from Precipitation	(lb/acre)	5	*Based on National Atmospheric Deposition Program NTN data for Site DE99, 2003-2008.
6	Compute Fertilizer?		FALSE	*If TRUE than fertilizer will be maximized after spray rate is determined. If FALSE then fertilizer will be set to zero.

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
7	Calendar days per month	days/mo	31	28	31	30	31	30	31	31	30	31	30	31	**365**	31	28	31	30	31	30	31	31	30	31	30	31	**365**
8																													
9	**Hydraulic Spray Application**																												
10	Spray hydraulic application rate[1]	in/week	0.90	0.76	0.87	0.92	0.96	1.42	1.65	1.65	1.65	1.51	1.27	1.14		0.90	0.76	0.87	0.92	0.96	1.42	1.65	1.65	1.65	1.51	1.27	1.14	
11	Spray hydraulic application rate	in/mo	4.00	3.04	3.86	3.94	4.26	6.08	7.30	7.31	7.07	6.70	5.44	5.03	**64.04**	4.00	3.04	3.86	3.94	4.26	6.08	7.30	7.31	7.07	6.70	5.44	5.03	**64.04**
12	Effluent Flow	MG/acre-mo	0.11	0.08	0.10	0.11	0.12	0.17	0.20	0.20	0.19	0.18	0.15	0.14	**1.74**	0.11	0.08	0.10	0.11	0.12	0.17	0.20	0.20	0.19	0.18	0.15	0.14	**1.74**
13	Effluent Flow	MG/mo	3.6	2.7	3.4	3.5	3.8	5.4	6.5	6.5	6.3	5.9	4.8	4.5	**56.8**	3.6	2.7	3.4	3.5	3.8	5.4	6.5	6.5	6.3	5.9	4.8	4.5	**56.8**
14																													
15	**Total Nitrogen Application**																												
16	Total nitrogen in spray effluent	mg/L	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0		30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	
17	Total nitrogen in spray effluent	lb/acre-mo	27.2	20.6	26.3	26.8	29.0	41.3	49.6	49.7	48.1	45.6	37.0	34.2	**435.4**	27.2	20.6	26.3	26.8	29.0	41.3	49.6	49.7	48.1	45.6	37.0	34.2	**435.4**
18	Maximum new nitrogen applied this month as fertilizer[2]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
19	Ferilizer nitrogen available [75% cur. mo. + 25% prev. mo.]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
20	Total nitrogen from precip. [line 5 weighted by line 42]	lb/acre-mo	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	**5.0**	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	**5.0**
21	Total nitrogen from fixation [50% of line 30 for legumes]	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
22	Total nitrogen applied [line 17 + line 19 + line 20 + line 21]	lb/acre-mo	27.6	21.0	26.7	27.1	29.4	41.7	50.1	50.3	48.5	46.0	37.3	34.6	**440.4**	27.6	21.0	26.7	27.1	29.4	41.7	50.1	50.3	48.5	46.0	37.3	34.6	**440.4**
23																													
24	**Ammonia Application**																												
25	Ammonia in spray effluent	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26	Ammonia in spray effluent	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
27																													
28	**Nitrogen Utilization**																												
29	Crop Name		LP	LP	LP	LP	LP	LP	LP	LP	LP	LP	LP	LP		LP	LP	LP	LP	LP	LP	LP	LP	LP	LP	LP	LP	
30	Crop Nitrogen Removal	lbs/acre-mo	7.3	4.1	6.4	11.1	15.2	24.5	29.8	29.8	26.3	20.4	14.6	10.5	**200.0**	7.3	4.1	6.4	11.1	15.2	24.5	29.8	29.8	26.3	20.4	14.6	10.5	**200.0**
31	Assumed Denitrification	%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%		15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	
32	Denitrification [line 22 * line 31]	lb/acre-mo	4.14	3.15	4.01	4.07	4.41	6.26	7.51	7.54	7.27	6.89	5.60	5.19	**66.05**	4.14	3.15	4.01	4.07	4.41	6.26	7.51	7.54	7.27	6.89	5.60	5.19	**66.05**
33	Assumed Ammonia Volatilization	%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	
34	Ammonia Volatilization [line 26 * line 33]	lb/acre-mo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
35	Total nitrogen consumed [line 30 + line 32 + line 34]	lb/acre-mo	11.44	7.24	10.43	15.17	19.59	30.78	37.29	37.32	33.55	27.33	20.20	15.70	**266.05**	11.44	7.24	10.43	15.17	19.59	30.78	37.29	37.32	33.55	27.33	20.20	15.70	**266.05**

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
36	**Percolate Nitrogen Content**																												
37	Total nitrogen in percolate [max(line 22 - line 35, 0)]	lb/acre-mo	16.2	13.8	16.3	12.0	9.8	10.9	12.8	13.0	14.9	18.6	17.1	18.9	**174.3**	16.2	13.8	16.3	12.0	9.8	10.9	12.8	13.0	14.9	18.6	17.1	18.9	**174.3**
38	Total nitrogen in percolate	lb/mo	528	450	533	392	320	358	418	424	488	609	560	618	**5,698**	528	450	533	392	320	358	418	424	488	609	560	618	**5,698**
39																													
40	**Percolate Volume**																												
41	Spray Hydraulic Application [line 11]	in/mo	4.0	3.0	3.9	3.9	4.3	6.1	7.3	7.3	7.1	6.7	5.4	5.0	**64.0**	4.0	3.0	3.9	3.9	4.3	6.1	7.3	7.3	7.1	6.7	5.4	5.0	**64.0**
42	Climatolgical Normal Precipitation [Exhibit K-K]	in/mo	3.3	3.2	4.1	3.2	3.4	3.6	3.9	5.3	3.6	3.5	3.1	3.6	**43.8**	3.3	3.2	4.1	3.2	3.4	3.6	3.9	5.3	3.6	3.5	3.1	3.6	**43.8**
43	Total Hydraulic Loading [line 41 + line 42]	in/mo	7.3	6.2	8.0	7.1	7.7	9.7	11.2	12.6	10.7	10.2	8.5	8.6	**107.8**	7.3	6.2	8.0	7.1	7.7	9.7	11.2	12.6	10.7	10.2	8.5	8.6	**107.8**
44	Thornwaite Potential Evapotranspiration [Exhibit J-J]	in/mo	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	**27.8**	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	**27.8**
45	Percolate volume [line 43 - line 44]	in/mo	7.2	6.1	7.3	5.3	4.4	4.9	5.7	7.7	7.1	8.3	7.6	8.4	**80.0**	7.2	6.1	7.3	5.3	4.4	4.9	5.7	7.7	7.1	8.3	7.6	8.4	**80.0**
46	Percolate volume	MG/mo	6.4	5.4	6.4	4.7	3.9	4.3	5.1	6.8	6.3	7.4	6.8	7.5	**71.0**	6.4	5.4	6.4	4.7	3.9	4.3	5.1	6.8	6.3	7.4	6.8	7.5	**71.0**
47																													
48	**Percolate Nitrogen Concentration**																												
49	Total nitrogen in percolate [line 38]	lb/mo	528	450	533	392	320	358	418	424	488	609	560	618	**5,698**	528	450	533	392	320	358	418	424	488	609	560	618	**5,698**
50	Percolate volume [line 46]	MG/mo	6	5	6	5	4	4	5	7	6	7	7	7	**71**	6	5	6	5	4	4	5	7	6	7	7	7	**71**
51	Total nitrogen concentration in percolate	lb/MG	83	83	83	83	83	83	83	62	78	83	83	83	**966**	83	83	83	83	83	83	83	62	78	83	83	83	**966**
52	**Nitrogen concentration in percolate (Design)**	**mg/L**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**7.4**	**9.3**	**9.9**	**9.9**	**9.9**		**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**9.9**	**7.4**	**9.3**	**9.9**	**9.9**	**9.9**	
													Design Maximum		**9.9**											Design Maximum		**9.9**

1) This is a user defined field. In general, the two approaches to setting values are either determine the maximum application rate which does not exceed the maximum spray rate or the percolate nitrogen limit (which may represent more volume than is available in the storage lagoon, especially in the summer), or to estimate actual monthly application rates based on available volume and operational preference and confirm that percolate is below the maximum. For design purposes, the maximum application rate methodology was used. These values can be adjusted during operations to explore specific scenarios.

2) This is a user defined field. For design purposes, the values are set as the maximum fertilizer application rate which does not exceed the perolate nitrogen limit, and is calculated after the spray application rate has been determined. Note that if less spray is applied in a given month (such as in the summer months where the design maximum spray exceeds the available volume), the amount of allowable fertilizer would increase. These values can be adjusted during operations to explore specific scenarios. If "Calculate Fertilizer?" is set to FALSE, fertilizer application is set to zero.

Facility:
ANSRWRF - Phase 1

Location:
ANSRWRF Storage Lagoon

Scenario:
Design 2-Year Cycle, Maximize Monthly Spray, Limit 1.65 in/week

Design Criteria

	Parameter	Unit	Value	Notes
1	Aveage Inflow	(MGD)	1.5	
2	Lagoon Surface Acreage	(acre)	19.4	*Top of lagoon
3	Initial Storage Volume (Design)	(MG)	13.8	*This should be set to equal the Cumulative Volume Stored for December of the second year.
4	Ending Volume - Starting Volume	(MG)	0.0	*If greater than 0 then lagoon volume has not recovered in two-year cycle and future years may have higher required storage volume than calculated.
5	Total Storage Volume Required	(MG)	**65.2**	*Calculated as the maximum Cumulative Volume Stored.

	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
6	Calendar days per month	days/mo	31	28	31	30	31	30	31	31	30	31	30	31	**365**	31	28	31	30	31	30	31	31	30	31	30	31	**365**
7	Inflow Volume to Lagoon [line 1 * line 6]	MG/mo	46.50	42.00	46.50	45.00	46.50	45.00	46.50	46.50	45.00	46.50	45.00	46.50	**547.5**	46.50	42.00	46.50	45.00	46.50	45.00	46.50	46.50	45.00	46.50	45.00	46.50	**547.5**
8	Climatolgical 5-Year Precipitation [Exhibit K-K]	in/mo	4.70	4.40	5.60	4.50	5.00	5.10	6.30	8.20	5.20	5.40	4.60	5.20	**64.20**	4.70	4.40	5.60	4.50	5.00	5.10	6.30	8.20	5.20	5.40	4.60	5.20	**64.20**
9	Volume Added by Precipitation [line 2 * line 8]	MG/mo	2.48	2.32	2.95	2.37	2.63	2.69	3.32	4.32	2.74	2.84	2.42	2.74	**33.82**	2.48	2.32	2.95	2.37	2.63	2.69	3.32	4.32	2.74	2.84	2.42	2.74	**33.82**
10	Outflow Volume to Spray[1]	MG/mo	36.35	30.61	36.35	34.02	72.29	86.09	94.52	94.55	44.33	46.12	44.27	44.20	**663.7**	37.03	34.75	58.41	74.31	71.23	36.62	84.23	94.55	91.50	69.82	39.45	42.83	**734.7**
11	Thornwaite Potential Evapotranspiration [Exhibit J-J]	in/mo	0.10	0.10	0.70	1.80	3.30	4.80	5.50	4.90	3.60	1.90	0.90	0.20	**27.80**	0.10	0.10	0.70	1.80	3.30	4.80	5.50	4.90	3.60	1.90	0.90	0.20	**27.80**
12	Volume Lost to Evaporation [line 2 * line 11]	MG/mo	0.05	0.05	0.37	0.95	1.74	2.53	2.90	2.58	1.90	1.00	0.47	0.11	**14.64**	0.05	0.05	0.37	0.95	1.74	2.53	2.90	2.58	1.90	1.00	0.47	0.11	**14.64**
13	Volume Stored [line 7 + line 9 - line 10 - line 12]	MG/mo	12.6	13.7	12.7	12.4	-24.9	-40.9	-47.6	-46.3	1.5	2.2	2.7	4.9		11.9	9.5	-9.3	-27.9	-23.8	8.5	-37.3	-46.3	-45.7	-21.5	7.5	6.3	
14	Cumulative Volume Stored [max(prev. month + line 13, 0)]	MG	26.4	40.0	52.8	65.2	40.3	0.0	0.0	0.0	1.5	3.7	6.4	11.3		23.2	32.7	23.4	0.0	0.0	8.5	0.0	0.0	0.0	0.0	7.5	13.8	

1) This is a user defined field which is set to the sum of Effluent Flow to each of the fields in the associated nitrogen balance spreadsheets. For design purposes, this Effluent Flow is the calculated maximum flow which does not exceed the spray rate limitations or percolate nitrogen limitations. It therefore may be greater than the actual volume available to spray. These values can be adjusted during operations to explore specific scenarios.

Appendix D - Collection System Plans

D.1 Allen Harim Monitoring Building Plans

(See attached plan set.)

D.2 Force Main Plans

(See attached plan set.)

Appendix E - Disposal System Plans

E.1 Lagoon and Pump Station Plans

(See attached plan set.)

E.2 Disposal System Plans

(See attached plan set.)

Appendix F - Equipment O&M Manuals

F.1 Aqua-Jet O&M Manual

F.2 Effluent Spray Pumps O&M Manual

F.3 Center Pivot O&M Manual

F.4 Irrigation Z-Pipe Manual

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Aqua-Jet®

Surface Mechanical Aerator

Installation, Operation & Maintenance Manual

For

Artesian Northern Sussex Regional Water Recharge Facility

Milton, Delaware

Specification 11600 – Surface Mechanical Aerators
AASI Project I.D. # 114194A / 83811
Date: April 5, 2018

Aeration & Mixing | Biological Processes | Filtration | Membranes | Process Control & Monitoring | Aftermarket Parts & Services

6306 N. Alpine Rd. Loves Park, IL 61111-7655 p 815.654.2501 f 815.654.2508 www.aqua-aerobic.com

Aqua-Jet® Surface Mechanical Aerator
Table of Contents

Aqua-Jet® Surface Mechanical Aerator
Table of Contents

Aqua-Jet® Surface Mechanical Aerator
Table of Contents

Section 5 Mechanical Drawings

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Project Associates

OWNER

Artesian Wastewater Management, Inc.
644 Churchman's Road
Newark, DE 19702
Phone: 302-453-2396

CONTRACTOR

Corrado Construction Company
210 Marsh Lane
New Castle, DE 19720
Phone: 302-652-3339

ENGINEER

Duffield Associates
5400 Limestone Road
Wilmington, DE 19808
Phone: 302-239-6634

AQUA-AEROBIC SALES REPRESENTATIVE

Envirep/TLC Environmental, Inc.
254 Beacon Drive
Phoenixville, PA 19460
Phone: 717-972-0852

AQUA-AEROBIC PROJECT MANAGER

Laurie Breit
6306 North Alpine Road
Loves Park, IL 61111-7655
Phone: 815/639-4539
Fax: 815/654-8623
Email: lbreit@aqua-aerobic.com

Project Name:	ARTESIAN NORTHERN SUSSEX REGIONAL WATER RECHARGE FACILITY (ANSRWRF) – CONTRACT A – STORAGE LAGOON
Project Location:	SUSSEX COUNTY, DELAWARE
AASI Project ID:	114194A

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AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

WARRANTY; LIMITATION OF LIABILITY; AND DISCLAIMER

In return for purchase and full payment for Aqua-Aerobic Systems, Inc. goods, we warrant new goods provided by us to be free from defects in materials and workmanship under normal conditions and use for a period of one year from the date the goods are put into service, or eighteen months from date of shipment (whichever first occurs). If the goods include an Endura Series® motor, the complete Endura Series unit shall be warranted by Aqua to be free from defects in materials and workmanship under normal conditions and use for three years from the date the product is put into service or 42 months from the date of shipment (whichever occurs first). **OUR OBLIGATION UNDER THIS WARRANTY IS EXPRESSLY AND EXCLUSIVELY LIMITED** to replacing or repairing (at our factory at Loves Park, Illinois) any part or parts returned to our factory with transportation charges prepaid, and which our examination shall show to have been defective. Prior to return of any goods or its parts to our factory, Buyer shall notify Aqua-Aerobic Systems, Inc. of claimed defect, and Aqua-Aerobic Systems, Inc. shall have the privilege of examining the goods at Buyer's place of business at or where the goods have otherwise been placed in service. In the event this examination discloses no defect, Buyer shall have no authority to return the goods or parts to our factory for the further examination or repair. All goods or parts shall be returned to Buyer, F.O.B. Loves Park, Illinois. This warranty shall not apply to any goods or part which has been repaired or altered outside our factory, or applied, operated or installed contrary to our instruction, or subjected to misuse, chemical attack/degradation, negligence or accident. This warranty and any warranty and guaranty of process or performance shall no longer be applicable or valid if any product, including any software program, supplied by Aqua-Aerobic Systems, Inc., is modified or altered without the written approval of Aqua-Aerobic Systems, Inc. Our warranty on accessories and component parts not manufactured by us is expressly limited to that of the manufacturer thereof.

THE FOREGOING WARRANTY IS MADE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, AND OF ALL OTHER LIABILITIES AND OBLIGATIONS ON OUR PART, INCLUDING ANY LIABILITY FOR NEGLIGENCE, STRICT LIABILITY, OR OTHERWISE; AND ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IS EXPRESSLY DISCLAIMED; AND WE EXPRESSLY DENY THE RIGHT OF ANY OTHER PERSON TO INCUR OR ASSUME FOR US ANY OTHER LIABILITY IN CONNECTION WITH THE SALE OF ANY GOODS PROVIDED BY US. THERE ARE NO WARRANTIES OR GUARANTEES OF PERFORMANCE UNLESS SPECIFICALLY STATED OTHERWISE.

UNDER NO CIRCUMSTANCES, INCLUDING ANY CLAIM OF NEGLIGENCE, STRICT LIABILITY, OR OTHERWISE, SHALL AQUA-AEROBIC SYSTEMS, INC. BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, COSTS OF CONNECTING, DISCONNECTING, OR ANY LOSS OR DAMAGE RESULTING FROM A DEFECT IN THE GOODS. LIMIT OF LIABILITY: AQUA-AEROBIC SYSTEMS, INC.'S TOTAL LIABILITY UNDER THE ABOVE WARRANTY IS LIMITED TO THE REPAIR OR REPLACEMENT OF ANY DEFECTIVE PART. THE REMEDIES SET FORTH HEREIN ARE EXCLUSIVE, AND OUR LIABILITY WITH RESPECT TO ANY CONTRACT OR SALE, OR ANYTHING DONE IN CONNECTION THEREWITH, WHETHER IN CONTRACT, IN TORT, UNDER ANY WARRANTY, OR OTHERWISE, SHALL NOT, IN ANY CASE, EXCEED THE PRICE OF THE GOODS UPON WHICH SUCH LIABILITY IS BASED.

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Aqua-Jet® Surface Mechanical Aerator Equipment
Furnished Components List

Equipment specifically listed below will be furnished by Aqua-Aerobic Systems:

UNITS

Equipment	HP Size	Model	Weight	Qty.	Volts
Aqua-Jet® Aerator Unit Part # 42H7511-R-L, Power Section Part # 22H7511-R-L, Motor Part # 24H7501-L,	75	FSS Endura® Series	2,835.0 lbs.	(2)	460

AUXILIARY EQUIPMENT

Aerator Unit Accessories	Material	Weight	Qty.	Part Number
Mooring Frame Assembly	304SS	248.0 lbs,	(4)	2901431
Mooring Stop Frame Assembly	304SS	256.0 lbs.	(4)	2960956

Electrical Cable and Accessories:	Unit Size	Qty.	Part Number
Electrical Cable #1/0-4 conductor,	1.79 DIA.	(1,000 ft.)	2607465
Motor Cord Grip 2 1/2" NPT,	1.38 - 1.75 Diameter, Galv.	(2)	2608039
Reducing Bushing	3" x 2 1/2" NPT, Galv.	(2)	2603238
Spiral Wrap - Abrasion Protection	(#1/0 Elec. Cable)	(2)	2614667
Strain Relief Grip Assy.	2-eye 304SS with snap hook	(4)	2961701
FRP Cable Float Assembly	w/ Cable ties	(100)	2963495

We confirm only those items specifically listed within the "Furnished Components List" document is supplied by Aqua. The following supplemental information is provided to communicate that the manufacturer has complied with all materials and specifications for the equipment scope of supply, material of construction, and level of responsibility.

1. The power cable length has been supplied as a single length of 1000 foot for field cutting and installation into the motor conduit box with the electrical accessories; cord grips, reducing bushings, and the strain relief grip assemblies as listed above in the materials list. Refer to the electrical wiring diagram within the motor conduit box, or the one within Section-4 of this manual for field wiring.
2. Endura® Series premium efficient motors will be provided and shall deliver 75 HP at 1200 RPM, and shall be wired for 460 volt, 60 cycles, 3 phase service. Motor windings shall be non-hygroscopic, with NEMA class F insulation, 1.15 service factor, and shall be totally enclosed, fan-cooled, with cast iron construction, and rated for severe chemical duty.
3. The Endura® Series motors shall be warranted for a period of three (3) years for defects in materials and workmanship and three (3) years as a no maintenance (greasing) unit. For details refer to the Warranty; Limitation of Liability; and Disclaimer within this manual.
4. The aerator assembly may be easily lifted and handled with a crane and strapping from the lifting eyes on the side of the motors.

5. Aqua will provide a spiral wrap abrasion protection sleeve for field installation by others to protect the electrical power cable from possible wear due to rubbing on the edge of the float. Refer to the Spiral Wrap Installation Instructions within Section-2 of the manual for details.
6. The 75 HP aerators shall have a one-piece shaft continuous from the top motor bearing, through the lower bearing, and down to and through the propeller. The motor / propeller shaft will be provided as 2 1/2 inches in diameter, and that the shafts are constructed of ASTM A476, Grade 30, and Type 17-4 PH Stainless Steel, in the 1150 HT condition, with minimum yield strength of 135,000 PSI.
7. The propeller for the 75 HP aerator shall be a two-blade, left-handed, marine type precision casting of stainless steel and 19 ½ inch diameter, and is capable of being reversed to cause back flow liquid movement without causing damage to the chassis, or liquid damage to the motor bearing and windings. The propeller will be pitch balanced to ensure equalization of load under full flow operation. Each blade's pitch and rake shall not vary more the 2.0 percent from the other. Pitch balance data shall be included on Aqua's Factory Test Certification and included in the O&M manual after production is completed.
8. Each aerator will be dynamically tested within 2.0 mils peak-to-peak horizontal displacement measured at the upper and lower motor bearings.
9. The aerator shall have 2,660 pounds reserve buoyancy based on nominal unit / equipment weights of the standard unit specifications to ensure stability and flotation. The float shall be a minimum of 114 3/4 inches in diameter and 15 1/4” thick, and shall be fabricated from UV resistance Fiberglass Reinforced Polyester and a minimum 30% glass content. The Bowl must be glassed as one complete unit to prevent leakage, and the lid must be glued in place after foam filling with the gap between the bowl and lid filled with a glass/resin compound.
10. The 75 HP aerators shall have a spray pattern approximately 30.0 feet in diameter, and 2.8 foot in height.
11. The Mooring Frame Assemblies 2901431, and the Mooring Stop Frame Assemblies 2960956, supplied will require field assembly by others per the installation drawings provided in Section-5.
12. The O & M Manuals are intended to be used for the planned training session as outlined in the Manufacturers Training document EP-10284.

We thank you again for your order and trust this instruction manual meets your needs. We look forward to working with you during the installation of your equipment.

Artesian Northern Sussex Regional Water Reclamation Facility
Sussex County, DE
Duffield Associates

Objective: To size Aqua-Jet aerators for an aerated lagoon.

Design Data:

Wastewater Characteristics

Average Flow	=	1.50 MGD
Peak Flow	=	2.00 MGD
Influent BOD	=	10 mg/l
Influent TSS	=	10 mg/l
Influent TKN	=	30 mg/l

Basin Dimensions

Approx. WS Dimensions	=	1055 ft x 775 ft
Approx. Bottom Dimensions	=	970 ft x 690 ft
Water Depth	=	17 ft
Approx. Side Slope	=	2.5:1
Approx. Surface Area	=	818,115 ft2
Approx. Volume	=	94 MG
Material	=	earthen
Elevation	=	45 ft

Scope: The scope consists of sizing Aqua-Jet aerators to provide partial mixing of a proposed lagoon that will store treated effluent.

Calculations:

Hydraulic Retention Time

HRT	=	94.38 MG / 1.5 MGD
	=	62.9 days

Power Requirements

Using 75 HP Aqua-Jet Aerators with a 380' zone of oxygen dispersion, partial mix conditions.

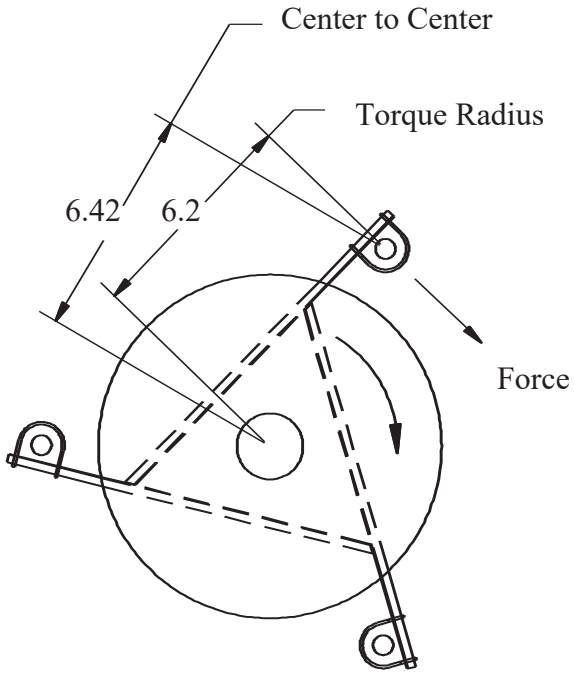
Power (based on O2 dispersion)	=	818,115 ft2 x (1) 75 HP Aqua-Jet/113,411 ft2 zone of O2 dispersion
	=	Seven (7) 7 HP

Recommendation: In order to maintain partial mix conditions, we recommend seven (7) 75 HPAqua-Jet aerators.

DMB

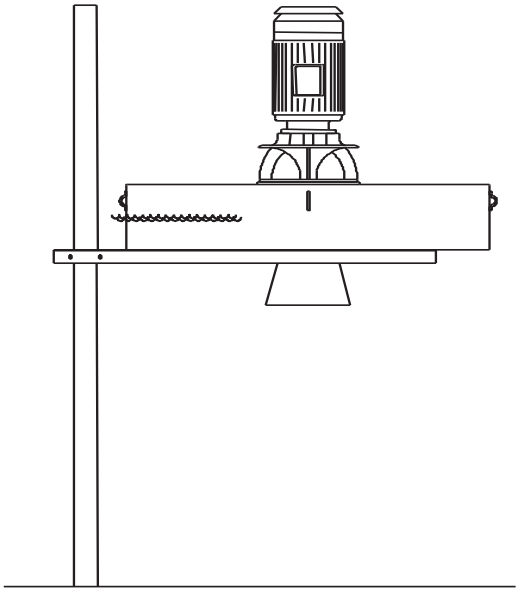
Design Calculations for Restrained Moored Aerator

Horsepower = 75
Max. Amount of Torque = 810 ft.-lbs. (Breakdown Torque of Motor)



$$\text{Reaction} = \frac{810\ \text{ft.-lbs.}}{3\ (\text{points}) \text{x}\ 6.2\ (\text{ft.})} = 43.55\ \text{lbs.}$$

Wind Load (at 40 lbs./ft^2)
Surface Area = 14.25 ft.^{2}
Wind Load = 570 lbs.



43.55 # Reaction
570.00 # Wind Load
613.55 # Total Post Load

 2017-05-22

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Manufacturer's Representative Certification

START-UP DATE:_____

PROJECT NAME	ARTESIAN NORTHERN SUSSEX REGIONAL WATER RECHARGE FACILITY (ANSRWRF) – CONTRACT A – STORAGE LAGOON
LOCATION	SUSSEX COUNTY, DELAWARE
OWNER	ARTESIAN WASTEWATER MANAGEMENT
CONTRACTOR	CORRADO CONSTRUCTION
ENGINEER	DUFFIELD ASSOCIATES
EQUIPMENT TYPE	SURFACE MECHANICAL AERATORS
EQUIPMENT SERIAL NUMBERS	

This will certify that Aqua-Aerobic Systems' Representative has satisfactorily completed start-up supervision services for the referenced equipment on the date first appearing above.

Respectfully,

Envirep/TLC Environmental, Inc.

_____
(Signature)

_____
(Name of Signatory)

SAMPLE

THIS CERTIFICATION WILL BE EXECUTED BY AQUA-AEROBIC SYSTEMS, INC. AFTER SUCCESSFUL START-UP OF EQUIPMENT FOR INSERTION INTO THE O&M MANUAL

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AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Manufacturer's Certificate of Installation

START-UP DATE:_____

PROJECT NAME	ARTESIAN NORTHERN SUSSEX REGIONAL WATER RECHARGE FACILITY (ANSRWRF) – CONTRACT A – STORAGE LAGOON
LOCATION	SUSSEX COUNTY, DELAWARE
OWNER	ARTESIAN WASTEWATER MANAGEMENT
CONTRACTOR	CORRADO CONSTRUCTION
ENGINEER	DUFFIELD ASSOCIATES
EQUIPMENT TYPE	SURFACE MECHANICAL AERATORS
EQUIPMENT SERIAL NUMBERS	TBD

This will certify that Aqua-Aerobic Systems, Inc. has inspected the installation of the equipment at the above project. We also certify that the equipment has been satisfactorily tested and is now ready for normal operation and use.

Respectfully,

William Decker,
Vice President & General Manager,
Equipment and Services Group

SAMPLE

THIS CERTIFICATION WILL BE EXECUTED BY AQUA-AEROBIC SYSTEMS, INC. AFTER SUCCESSFUL START-UP OF EQUIPMENT FOR INSERTION INTO THE O&M MANUAL.

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AQUA-AEROBIC SYSTEMS, INC.

Factory Test Certification

Aqua-Aerobic Systems Project ID # 114194A / SO # 83811

Customer:	Artesian Northern, DE						
Unit Data:							
HP:	75		Unit Type:	Aerator			
Model:	FSS		Unit No.:	1	of	2	
Float Serial No.:	N/A		Tagged:	N.A.			
Motor Data:							
Manufacturer:	Baldor / Reliance		Horsepower:	75			
Serial No.:	A1710192023		Model No.:	TEFC			
Volts: 230 / 240	Wired At:	460	Ph:	3	Hertz:	60	
N.P. Amps:	86.9		RPM:	1185			
NEMA Nominal Efficiency: 95			Propeller P/N: 2600037-LX0				
Balance:							
Top Bearing – Mils:	.3		Velocity: (in/sec):	.015			
Bottom Bearing – Mils:	.3		Velocity: (in/sec):	.012			
Balanced by:	Alex Stites		Date:	3/19/18			
Diameter / Pitch:	19.5 / 14.35						
Rake:	0						
Final Inspection By:	Alex Stites		3/19/18				
Certified by:	James A. Knight		Date				

AQUA-AEROBIC SYSTEMS, INC.

Factory Test Certification

Aqua-Aerobic Systems Project ID # 114194A / SO # 83811

Customer:	Artesian Northern, DE						
Unit Data:							
HP:	75		Unit Type:	Aerator			
Model:	FSS		Unit No.:	2	of	2	
Float Serial No.:	N/A		Tagged:	N.A.			
Motor Data:							
Manufacturer:	Baldor / Reliance		Horsepower:	75			
Serial No.:	A1707192090		Model No.:	TEFC			
Volts: 230 / 240	Wired At:	460	Ph:	3	Hertz:	60	
N.P. Amps:	86.9		RPM:	1185			
NEMA Nominal Efficiency: 95			Propeller P/N: 2600037-LX0				
Balance:							
Top Bearing – Mils:	1.7		Velocity: (in/sec):	.11			
Bottom Bearing – Mils:	1.6		Velocity: (in/sec):	.10			
Balanced by:	B. M.		Date:	10/19/17			
Diameter / Pitch:	19.5 / 14.7						
Rake:	0						
Final Inspection By:	Mike Harris		12/13/17				
Certified by:	James A. Knight		Date				