MEMBRANE BIOREACTOR WASTEWATER TREATMENT STRATEGIES FOR SENSITIVE COASTAL ENVIRONMENTS

MICHAEL C. GALLANT & MAURICE W. GALLARDA
Pluris Holdings LLC, USA

ABSTRACT

Southeastern North Carolina is predicted to experience an 80% population increase in the next 20 years, presenting challenges to water and wastewater infrastructure. Due to the topography and geology of the coastal plain environment, wastewater disposal can be problematic, historically utilizing large tracts of land for spray application or discharges directly into nutrient-sensitive waters. Previous treatment scenarios ranged from facultative lagoons to extended aeration processes. In order to meet the upcoming challenges posed by considerable growth, Pluris Holdings has embarked on designing, permitting and constructing a series of membrane bioreactor (MBR) wastewater treatment plants that produce effluents meeting groundwater and drinking water standards for nutrients. These plants have allowed for a wider array of disposal options requiring less land and capital costs than previous disposal systems, and they reduce the pollutant load to the receiving stream in the case of a direct discharge to coastal surface waters. Two methods for effluent disposal have been utilized in these plants. High rate infiltration (HRI) and national pollutant discharge elimination system direct discharge (NPDES). These methods reduce costs, require small amounts of land and responsibly deal with the disposal of wastewater. Due to the excellent quality of the MBR effluent, water reuse can also be utilized in conjunction with these two disposal methods. The use of MBR technology, innovative HRI disposal and/or NPDES disposal represent a paradigm change in waste-water treatment in the southeastern U.S. This change has required a close working relationship with the regulatory community. In this paper Pluris will discuss three separate projects including the design and permitting of each and the subsequent results, including effluent pollutant levels and reduced impacts on the environment.

Keywords: wastewater, MBR, membrane, nutrient, coastal North Carolina, NPDES, high rate infiltration.

1 INTRODUCTION

Southeastern North Carolina is expected to see a growth rate of 80% over the next 20 years. This environmentally sensitive area is the focus of this paper and the home to three advanced membrane bioreactor wastewater treatment facilities owned and operated by Pluris Holdings, LLC (Pluris), a privately held public utility.

Growth in southeastern North Carolina is driven primarily by a warm climate and rich environmental heritage. This rate of growth has been extremely challenging for previously rural municipalities that do not traditionally have the infrastructure or institutions capable of responding to the increased demand for services.

In the past, residents in the area relied heavily on primary treatment alternatives, such as individual on-site systems (septic tanks and nitrification fields), small package systems and larger primary treatments works consisting of facultative lagoons with spray application fields.

Historically, these systems were able to provide adequate treatment without undue stress on the local environment and surface waters. These surface waters have been routinely used for recreation, fishing and shellfish harvesting. They are a very large part of the coastal lifestyle and are prized by residents and visitors alike.

WIT Transactions on Ecology and the Environment, Vol 242, © 2020 WIT Press
www.witpress.com, ISSN 1743-3541 (on-line)
doi:10.2495/WP200121

The question presented to us is, how do local and regional governmental agencies absorb rapid growth and development without damaging the environment? Furthermore, how does a community create a sustainable model for wastewater treatment in such an environment?

In response to these challenges, Pluris has adopted membrane bioreactor (MBR) technology to achieve an excellent effluent quality that meets and/or exceeds groundwater and surface water standards for nutrients, primarily nitrogen and phosphorus.

Additionally, Pluris has pioneered the use of innovative in situ high rate infiltration (HRI) basins to dispose of effluent and create surplus groundwater that can be reused in the surrounding area without regulatory oversight.

2 DESCRIPTION OF THREE WASTEWATER TREATMENT FACILITIES

Pluris owns and operates three wastewater treatment plants in southeastern North Carolina. Fig. 1 shows the locations of the referenced membrane bioreactor wastewater treatment facilities in the coastal areas of southeast North Carolina.

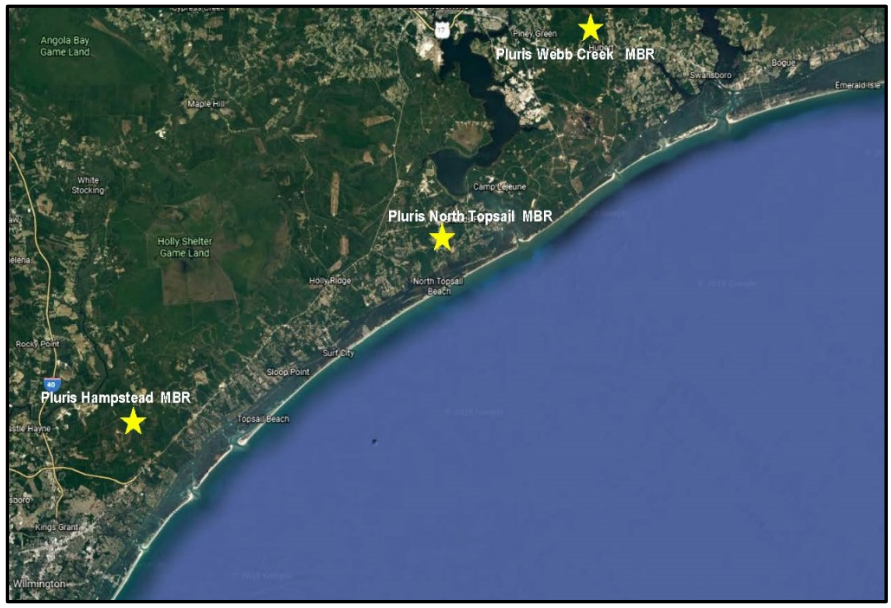

Figure 1: Locations of reference Pluris membrane bioreactor wastewater treatment facilities.

All of the systems are within 5 miles of the Atlantic Ocean, in North Carolina. These systems all border wetlands and/or tributaries of sensitive coastal waters. These waters range in state designations, from Class C to Class SA:HQW waters.

Class C waters are generally swamp waters and are not nutrient sensitive. Class SA:HQW waters are shell fishing waters and high quality waters used for recreational purposes. These waters can be nutrient sensitive, previously impaired and or primary nursery areas.

Historically, advances in treatment strategies have been focused on the regulatory landscape that existed at that time. Twenty-five years ago, most treatment plants were designed for 30/30 limits (30 mg/L BOD5 and 30 mg/L TSS). Today, treatment requirements have increased considerably. Pluris took the innovative step to provide treatment to levels

below these requirements and to provide the highest treatment levels in the region. All of the facilities discussed in the paper utilize 0.04 micron membranes and are designed to achieve an effluent concentration of total nitrogen (TN) of 4 mg/L and a total phosphorus (TP) concentration of 2 mg/L. See Table 1 for the design, permit and typical standard limits for nitrogen and nitrate (see appendix and [1], [2]).

Table 1: Limits set by North Carolina Department of Environmental Quality (NCDEQ).

Parameter	Pluris North Topsail	Pluris Hampstead	Pluris Webb Creek
Design Limit, Nitrate (mg/L)	1.88	1.88	0.16*
Permit Limit, TN (mg/L)[1],[2],[3]	4	4	2*
Groundwater Standard Nitrate (mg/L)[4]	10	10	10
Surface Water Standard Nitrate (mg/L)[5]	10	10	10
**** This limit is for Ammonia***			

2.1 Facility 1: Pluris North Topsail wastewater treatment facility

The Pluris North Topsail system was purchased in 2008 from another private utility. At that time the plant provided treatment for 3,316,000 liters per day using three facultative lagoons in series. After the lagoon treatment the effluent was disinfected with a tablet chlorinator before being applied to 162 hectares of spray fields.

These spray fields bordered on Mill Creek which has a stream classification of SA:HWQ. The operation was land intensive, and the surrounding area was under a moratorium for new sewer connections. The permit limits did not protect the receiving stream from the subsequent runoff that periodically occurred from spray fields, especially during the wet periods of the year. The lagoons were subject to large impacts from tropical rain events such as hurricanes and tropical storms.

Pluris purchased the plant and embarked on building a 1 million gallon per day (MGD) MBR plant. This plant disposed of the effluent into two below ground level HRI basins with an innovative design that enhanced infiltration operation and maintenance of the basins. The key component of this design was an engineered material used in the center dyke construction of the basins. This material consists of a well-graded washed sand material with an angular shape that resists rilling and sloughing compared to in-situ soils or typical sands found in the area.

The new MBR plant and the two basins were constructed on less than 5 acres of land and are capable of treating 1 MGD of wastewater to tertiary standards. Compare this with the previous plant, which provided primary treatment and used over 400 acres of land.

This improvement in treatment had a significant impact on the area. First, it greatly reduced the mass of pollutants being applied to the environment. Second, it allowed for the moratorium on sewer connections to be lifted. When the plant was first purchased it served 2,000 customers. Today the customer base is over 6,000.

The values in Table 2 for the MBR mass loading were calculated using the maximum concentration per the permitted limit and the design flow. The mass loading for the lagoons was calculated using a typical result from a sample taken on 9 October 2019.

Another innovation designed into this plant was the use of a surplus groundwater impoundment. The HRI basins are surrounded by an underdrain with gravity drains to an 8-acre pond. This pond can be used as a source of groundwater for reuse in the community. Pluris has since constructed a lift station and reuse force main to distribute this resource to

Table 2: Pluris North Topsail yearly mass pollutant loading MBR versus lagoon treatment.

Treatment	Flow	TN load per year
MBR	1.0 MGD (3.785 MLD)	12,176 lbs (5,523 kg)
Faculative lagoons	0.876 MGD (3.316 MLD)	34,666 lbs (15,724 kg)

Figure 2: Amenity pond for aesthetics and water reuse.

the community. Currently, this system distributes groundwater to an amenity pond at a nearby subdivision (Fig. 2).

As this community is developed, this pond will become a centerpiece of the community, providing wildlife habitat as well as a pleasing and aesthetic water feature.

2.2 Facility 2: Pluris Hampstead wastewater treatment facility

The Pluris Hampstead wastewater treatment plant was constructed in response to calls from the development community for sustainable wastewater treatment. The Hampstead community has experienced double digit growth year over year. In 1993, the area had a population of 32,959. Today, the population is 54,820 [3].

This is an increase of 66% in 25 years. The projected population by 2038 is 86,078 [3]. This is an increase of 57% from the current population. Growth trends show that the majority of this growth will occur in the greater Hampstead area due to its proximity to the coast and the larger metropolitan area of Wilmington.

The previous treatment strategies were largely dependent on individual on-site systems. This limited development and has had a history of poor compliance and oversight. Furthermore, water tables in the area are very shallow with most areas having a seasonal high water table of less than 36” below the existing grade. Rising sea levels will likely increase the failure of these systems, especially those that are at lower elevations and nearer the coast.

Pluris Hampstead has provided a regional and sustainable solution to these problems. Like the other Pluris systems, the Hampstead facility utilizes 0.04 micron membranes. Unlike the Pluris North Topsail MBR plant, Pluris Hampstead was permitted without the use of any means of post-membrane disinfection. Citing the United States Environmental Protection Agency (EPA) white paper on the subject, the Pluris design team was able to show that MBR technology alone is sufficient for bacteriological disinfection [4], [5].

Pluris Hampstead is a conjunctive disposal plant that has both non-discharge and Federal EPA National Pollution Discharge Elimination System (NPDES) permits. The non-discharge permit specifies the use of two HRI basins using the innovative design used in the Pluris NT plant. The NPDES permit was added at the request of the regulatory agency and was permitted with disinfection only because an NPDES permit required it as a redundant system.

The Pluris Hampstead MBR plant is equipped with a peracetic acid disinfection system to meet the NPDES requirements. Pluris was the first wastewater treatment plant in the state to use this method of disinfection. Peracetic acid is a very strong disinfectant that does not cause the formation of disinfection by-products like chlorine. Capital costs are inexpensive compared to ozone or ultraviolet light systems, and the metering system uses far less electricity.

It is important to note that the NPDES discharge has never been used at the Pluris Hampstead MBR plant.

Like the Pluris North Topsail plant, the Hampstead MBR plant has a surplus groundwater impoundment and is owned by a third party, allowing the owner to resell the surplus groundwater to the surrounding planned subdivisions for irrigation.

It is important to note that the discharge parameters for the NPDES permit are far less restrictive that those for the non-discharge permit. At the Hampstead facility the receiving stream is classified as C Swamp waters. Table 3 lists the typical limits for various parameters based on the two disposal methods (see appendix).

Table 3: Pluris Hampstead permit limits, non-discharge versus NPDES.

Parameter	Units	Non-discharge limit	NPDES limit
BOD 5	mg/L	10	5
Fecal coliform	#/100 mL	14	200
Total nitrogen	mg/L	4	No limit
Total phosphorus	mg/L	2	No limit
TSS	mg/L	15	30

Although the receiving stream at the Pluris Hampstead MBR plant is not as environmentally sensitive as other areas, the engineering design team believed it was important to treat the effluent to the highest standards. This avoids issues with the plant operations and also ensures compliance in the case of future effluent restrictions or a reclassification of the receiving stream.

2.3 Facility 3: Pluris Webb Creek wastewater treatment plant

Pluris Webb Creek is located in Hubert North Carolina. Prior to Pluris purchasing the aging original sequential batch reactor (SBR) facility, it had been in operation for over 25 years. Due to the poor operating record of the previous utility owners, the utility was seized by the North Carolina Utilities Commission (NCUC), and Pluris was appointed as the emergency operator. Pluris subsequently purchased the utility with the commitment to design and build a new MBR plant.

The SBR plant, under the auspices of the original owners had a storied history with the North Carolina Department of Environmental Quality (NCDEQ) having incurred over 400 violation notices. The plant regularly exceeded its bacteriological permit limits. Out of the

three facilities Pluris Webb Creek has the greatest potential effect on the coastal environment as it has a surface discharge NPDES permit, and the receiving stream is classified as SA:HQW.

In order to alleviate the future adverse environmental impacts, Pluris designed and is constructing a new 0.35 MGD MBR plant on the site. Like all other Pluris plants, this plant will utilize 0.04 micron membrane technology.

As of the writing of this paper, this plant is still nearing 50% completion. A recent drone photograph was taken showing an aerial view of the new MBR facility at Webb Creek (Fig. 3).

When complete this plant will eliminate the issue of bacteriological permit violations. It will also greatly reduce the concentrations of nitrogen and phosphorus in the effluent. Table 4 lists the design versus permit limits (see appendix).

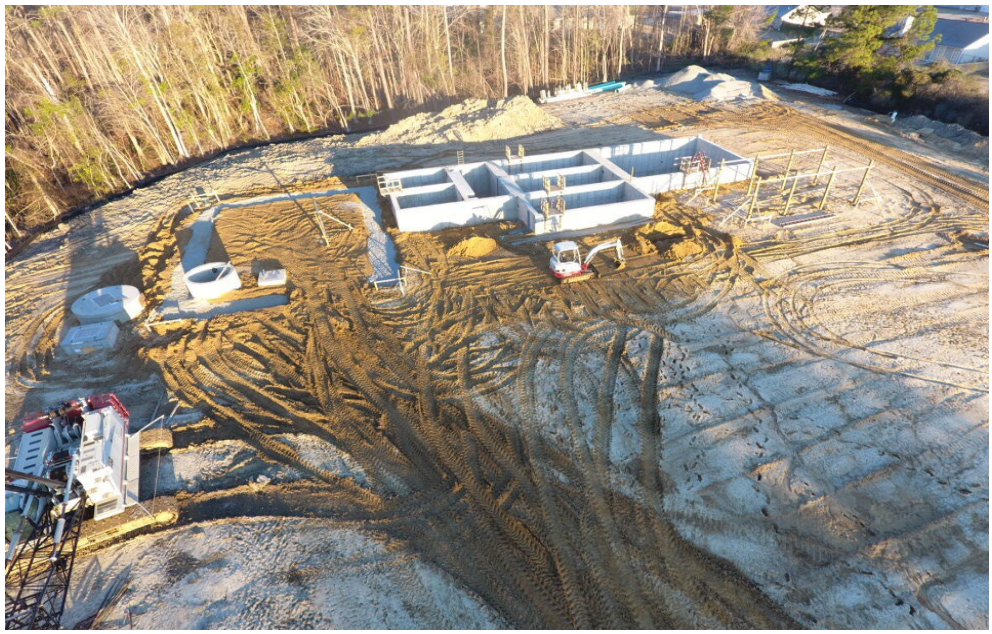

Figure 3: Aerial drone photograph of new Pluris Webb Creek MBR treatment facility.

Table 4: NCDEQ Pluris Webb Creek permit limits, design versus permit limits.

Parameter	**Units**	**Design**	**NPDES permit limit**
BOD 5	mg/L	5	12/6*
Fecal coliform	#/100 mL	14	200
Total nitrogen	mg/L	4	No limit
Total phosphorus	mg/L	2	No limit
TSS	mg/L	5	30
***Winter/Summer**			

3 PERMITTING CONSIDERATIONS

NPDES surface discharges are generally discouraged by the regulatory community in southeastern North Carolina. Several environmental groups regularly challenge applications for discharge permits including the North Carolina Coastal Federation, the White Oak River Keeper, the Cape Fear River Keeper and the North Carolina Shellfish Growers Association. These local environmentalists are concerned about the health of the coastal waters and strive to conserve not only the natural resources but the livelihood of the commercial fishing industry.

The Pluris team takes environmental concerns very seriously and works hard to find solutions that are reasonable, prudent, and environmentally responsible. The effluent from the three facilities discussed in this paper routinely have test results, as shown in Table 5 below showing pollutant levels as not detectable.

Table 5: Typical environmental laboratory test results.

Test	**Results**
Ammonia nitrogen	< 0.2 mg/L
Residual suspended (TSS)	< 2.5 mg/L
Total phosphorus	0.22 mg/L
BOD	< 2 mg/L
Nitrate nitrogen (calculated)	
Nitrite nitrogen	< 0.02 mg/L
Nitrite+nitrite-nitrogen	0.47 mg/L
Nitrate nitrogen	0.47 mg/L
Total nitrogen (calculated)	
Total Kjeldahl (TKN)	< 0.5 mg/L
Total nitrogen (calculated)	< 0.5 mg/L
Fecal coliform	2 MPN/100 mL

The NCDEQ is responsible for ensuring that the utilities meet all requirements for effluent parameters. All designs are reviewed and approved through the central office in Raleigh, North Carolina.

Due to the fact that Pluris regularly designs innovation into their plants, such as the referenced HRI basins and peracetic acid systems described above, permitting can be difficult. In some cases, the design team needed to meet with permit review staff and produce documentation and engineering data to show that technologies like MBR can be used with satisfactory results. MBR is used worldwide but is still relatively new in the U.S.

Just as the NCDEQ ensures that a plant will meet its permit limits, the NCUC regulates the utility such that rate payers are impacted as little as possible. Basically, the NCDEQ wants to ensure effluent quality regardless of cost, and the NCUC wants to make treatment as inexpensive as possible regardless of environmental impacts.

It is for this reason that Pluris regularly meets with the NCUC to discuss and review design plans prior to construction to avoid any issues.

4 CONCLUSION

All signs point to increasing regulatory oversight and tighter effluent restrictions for wastewater plants in southeastern North Carolina. The increasing population demands more services and infrastructure but at the same time desires that the natural heritage of the area be maintained.

Pluris has designed three treatment systems that meet or exceed regulatory limits and protect the surrounding environment. In some cases, reuse of surplus groundwater is available, increasing the sustainability of the system. There may come a time when reuse is mandated by the regulatory community. At that time, effluent quality will determine how that water can be reused. By exceeding standards for groundwater and surface water, Pluris has provided the most responsible and viable business model. Future considerations will most likely include an array of reuse options as well as indirect potable reuse.

REFERENCES

[1] North Carolina Department of Environmental Quality (NCDEQ), 02L Groundwater Standards Table 5-21, 2013. https://files.nc.gov/ncdeq/documents/files/02L%20Groundwater%20Standards%20Table%205-21%202013_0.pdf. Accessed on: 14 Dec. 2019.

[2] North Carolina Department of Environmental Quality, NC Surface Water Quality Standards Table. https://deq.nc.gov/documents/nc-stdstable-06102019. Accessed on: 13 Dec. 2019.

[3] North Carolina Office of State Budget and Management, Raleigh, NC. www.osbm.nc.gov/demog/county-projections. Accessed on: 15 Dec. 2019.

[4] Francy, D.S. et al., *Quantifying Viruses and Bacteria in Wastewater – Results, Interpretation Methods, and Quality Control*, United States Geological Service, 2011.

[5] Francy, D.S. et al., Comparative effectiveness of membrane bioreactors, conventional secondary treatment, and chlorine and UV disinfection to remove microorganisms from municipal wastewaters. *Water Research*, **46**, pp. 4164–4178, 2012.

APPENDIX

Figure A1: Pluris Hampstead non-disharge permit attachment “A”. Available on request from author.

PPI 002 – Membrane Bio-Reactor Treatment System Effluent

EFFLUENT CHARACTERISTICS		EFFLUENT LIMITS					MONITORING REQUIREMENTS	
PCS Code	Parameter Description	Units of Measure	Monthly Average	Monthly Geometric Mean	Daily Minimum	Daily Maximum	Measurement Frequency	Sample Type
00310	BOD, 5-Day (20 ºC)	mg/L	10				3 x Week	Composite
00940	Chloride (as Cl)	mg/L					3 x Year [1]	Composite
31616	Coliform, Fecal MF, M-FC Broth, 44.5 ºC	#/100 mL		14			3 x Week	Grab
50050	Flow, in Conduit or thru Treatment Plant	GPD	1,000,000				Continuous	Recording
00610	Nitrogen, Ammonia Total (as N)	mg/L	4				3 x Week	Composite
00625	Nitrogen, Kjeldahl, Total (as N)	mg/L					3 x Week	Composite
00620	Nitrogen, Nitrate Total (as N)	mg/L	10				3 x Week	Composite
00600	Nitrogen, Total (as N)	mg/L	4				3 x Week	Composite
00400	pH	su			6	9	5 x Week	Grab
00665	Phosphorus, Total (as P)	mg/L	2				3 x Week	Composite
70300	Solids, Total Dissolved – 180 ºC	mg/L					3 x Year [1]	Composite
00530	Solids, Total Suspended	mg/L	15				3 x Week	Composite

1. 3 x Year sampling shall be conducting in March, July and November.

WIT Transactions on Ecology and the Environment, Vol 242, © 2020 WIT Press
www.witpress.com, ISSN 1743-3541 (on-line)

Figure A2: Pluris Hampstead non-discharge permit attachment “A”. Available on request from author.

ATTACHMENT A -LIMITATIONS AND MONITORING REQUIREMENTS Permit Number: WQ0037287 Version: 1.0

PPI 001 -WWTP Effluent

EFFLUENT CHARACTERISTICS		EFFLUENT LIMITS					MONITORING REQUIREMENTS	
PCS Code	Parameter Description	Units of Measure	Monthly Average	Monthly Geometric Mean	Daily Minimum	Daily Maximum	Measurement Frequency	Sample Type
00310	BOO,5-Day(20°C)	mg/L	10				2x Month	Composite
00940	Chloride(asCl)	mg/L					3x Year [1]	Composite
31616	Coliform,FecalMF,M-FC Broth,44.5°C	#/100mL		14			2x Month	Grab
50050	Flow,inConduit orthru Treatment Plant	GPO	50,000				Continuous	Recorder
00610	Nitrogen, Ammonia Total (as N)	mg/L	4				2x Month	Composite
00625	Nitrogen, Kjeldahl, Total (as N)	mg/L					2x Month	Composite
00620	Nitrogen, Nitrate Total (as N)	mg/L	10				2x Month	Composite
00600	Nitrogen, Total (as N)	mg/L	4				2x Month	Composite
00400	pH	SU			6	9	5x Week	Grab
00665	Phosphorus, Total (as P)	mg/L	2				2x Month	Composite
70300	Solids, Total Dissolved - 180°C	mg/L					3x Year [1]	Composite
00530	Solids, Total Suspended	mg/L	15				2x Month	Composite

1. 3x Year sampling shall be conducted in March, July and November.

WIT Transactions on Ecology and the Environment, Vol 242, © 2020 WIT Press
www.witpress.com, ISSN 1743-3541 (on-line)

Figure A3: Pluris Hampstead NPDES permit page 3 of 7, Available on request from author.

Permit NC0089524

A. (1) EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS
[I5 A NCAC 02B .0400 et seq., 02B .0500 et seq.]

a. During the period beginning on the effective date of the permit and after receipt of the signed Engineering Certificate indicating completion of construction, and lasting until expiration, the Permittee is authorized to discharge treated domestic wastewater from *Outfall 001.* Such discharges shall be limited and monitored [1] by the Permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS		MONITORING REQUIREMENTS		
	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type	Sample Location
Flow	0.25 MGD		Continuous	Recording	Effluent
BOD, 5-Day, 20°c	5.0 mg/L	7.5 mg/L	3/Week	Composite	Effluent
Total Suspended Solids	30 mg/L	45 mg/L	3/Week	Composite	Effluent
NH3-N (April I – October 31)	I .I mg/L	5.5 mg/L	3/Week	Composite	Effluent
NH3-N (November I -March 31)	2.5 mg/L	12.5 mg/L	3/Week	Composite	Effluent
Fecal Coliform (geometric mean)	200/100 mL	400/100 mL	3/Week	Grab	Effluent
pH	Not less than 6.0 S.U. nor greater than 9.0 S.U.		3/Week	Grab	Effluent
Dissolved Oxygen	Not less than 5.0 mg/L, daily average		3/Week	Grab	Effluent
Dissolved Oxygen, mg/L [2]			Weekly	Grab	Upstream & Downstream
Total Residual Chlorine [3]		17 µg/L	Weekly	Grab	Effluent
Temperature, °C	Monitor and Report		Daily	Grab	Effluent
Temperature, °C [2]	Monitor and Report		Weekly	Grab	Upstream & Downstream
Total Nitrogen, mg/L [4]	Monitor and Report		Quarterly	Composite	Effluent
Total Phosphorus, mg/L	Monitor and Report		Quarterly	Composite	Effluent
Chronic Toxicity [5]			Quarterly	Composite	Effluent

Footnotes:

1. No later than 270 days from the effective date of this permit, begin submitting discharge monitoring reports electronically using NC DWR's eDMR application system. See special condition A. (4).
2. Upstream approximately 50 feet from the outfall and downstream approximately 870 ft from the outfall, at locations approved by Wilmington Regional Office. All instream samples shall be collected during a discharge event.
3. Total Residual Chlorine (TRC) limit and monitoring only apply if chlorine or chlorine derivative are used for cleaning the MBR units and is in contact with the wastewater. When required the facility shall monitor and report all effluent TRC values reported by a NC certified laboratory including field certified. However, effluent values below 50 µg/L will be treated as zero for compliance purposes.
4. Total Nitrogen (TN) = (N02-N + N03-N) + TKN, where (N02-N + N03-N) and TKN are Nitrite/Nitrate Nitrogen and Total Kjeldahl Nitrogen respectively.
5. Chronic Toxicity *(Ceriodaphnia)* @ 88.6%; February, May, August and November, see special condition A. (2).

b. There shall be no discharge of floating solids or visible foam in other than trace amounts.

WIT Transactions on Ecology and the Environment, Vol 242, © 2020 WIT Press
www.witpress.com, ISSN 1743-3541 (on-line)

Figure A4: Pluris Webb Creek NPDES permit attachment "A". Available on request from author.

Permit NC0089877

A. (2.) EFFLUENT LIMITS AND MONITORING REQUIREMENTS
[15A NCAC 02B.0400 et seq., 02B.0500 et seq.]
Grade III Biological WPCS [15A NCAC 08G .0302]

During the period beginning upon the submittal of an Engineer's Certificate and lasting until expiration, the Permittee is authorized to discharge treated wastewater from outfall 001. Such discharges shall be limited and **monitored**[1] by the Permittee as specified below:

EFFLUENT CHARACTERISTICS	EFFLUENT LIMITS			MONITORING REQUIREMENTS		
Parameter Description – eDMR code	Monthly Average	Daily Maximum	Unit of Measure	Measurement Frequency	Sample Type	Sample Location[1]
Flow, in conduit or thru treatment plant [50050]	0.350		MGD	Continuous	Recorder	Influent or Effluent
BOD, 5-Day (20 Deg. C) [CO310] - Winter	10.0	15.0	mg/L	3 / week	Composite	Effluent
BOD, 5-Day (20 Deg. C) [CO310] - Summer	5.0	7.5	mg/L	3 / week	Composite	Effluent
Solids, Total Suspended [CO530]	30.0	45.0	mg/L	3 / week	Composite	Effluent
Nitrogen, Ammonia Total (as N) [CO610] - Winter	2.0	10.0	mg/L	3 / week	Composite	Effluent
Nitrogen, Ammonia Total (as N) [CO610] - Summer	1.0	5.0	mg/L	3 / week	Composite	Effluent
Temperature, Water Deg. Centigrade [00010]			deg. C	Daily (5/week)	Grab	Effluent
DO, Oxygen, Dissolved[2] [00300]			mg/L	3 / week	Grab	Effluent
Phosphorus, Total (as P) [CO665]			mg/L	Weekly	Composite	Effluent
Nitrogen, Total (as N) [CO600]			mg/L	Quarterly	Composite	Effluent
Fecal Coliform [31616]	200/100 mL	400/100 mL	cfu/100ml	3 / week	Grab	Effluent
pH [00400]	Between 6.8 and 8.5 Standard Units		s.u.	3 / week	Grab	Effluent
pH [00400]	Monitor and Report		s.u.	Weekly	Grab	Upstream & Downstream
Temperature, Water Deg. Centigrade [00010]	Monitor and Report		deg. C	Weekly	Grab	Upstream & Downstream
DO, Oxygen, Dissolved [00300]	Monitor and Report		mg/L	Weekly	Grab	Upstream & Downstream

*Winter: November 1 - March 31, *Summer: April 1 – October 31

Footnotes:
1. Upstream = at least 100 feet upstream from the outfall. Downstream = at the nearest road.
2. The minimum daily Dissolved Oxygen effluent concentration shall not be less than 6.0 mg/L.
4. Total Residual Chlorine (TRC) limit and monitoring only apply if chlorine or chlorine derivative are used for cleaning the MBR units and is in contact with the wastewater. When required the facility shall monitor and report all effluent TRC values reported by a NC certified laboratory including field certified. However, effluent values below 50 µg/L will be treated as zero for compliance purposes.

There shall be no discharge of floating solids or visible foam in other than trace amounts.