New Jersey Pinelands Commission

Alternate Design Treatment Systems Pilot Program

November 5, 2019 Implementation Report

NEW JERSEY PINELANDS ALTERNATE DESIGN WASTEWATER TREATMENT SYSTEMS PILOT PROGRAM

IMPLEMENTATION REPORT

NOVEMBER 5, 2019

THE NEW JERSEY PINELANDS COMMISSION

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Pilot Program Implementation

The Pinelands Comprehensive Management Plan (CMP) (N.J.A.C. 7:50 et seq.) requires the periodic assessment and reporting on the status of the Alternate Design Wastewater Treatment Systems Pilot Program (pilot program). This report, dated November 5, 2019, is the fifth in a series of implementation reports presented to the Pinelands Commission pursuant to the requirements of the CMP. Previous implementation reports were dated November 5, 2006, November 5, 2009, November 5, 2012, and November 5, 2017- updated on April 27, 2018. Annual reports, also required by the CMP, have been issued each year since the start of the pilot program. The latest annual report, dated August 5, 2019, is available on the Pinelands Commission's website at: https://www.nj.gov/pinelands/landuse/current/altseptic/FINAL%202019%20SEPTIC%20PILOT%20PROGRAM%20ANNUAL%20REPORT%20(PL%20Edits)%20(2).pdf.

To date, three pilot program technologies (Amphidrome, Bioclere and FAST) have been formally recognized by the Commission as being capable of meeting Pinelands water quality standards when used to serve residential development. The Amphidrome and Bioclere technologies have been confirmed to meet the Commission's water quality standard when used on one acre parcels. The FAST technology has been confirmed to meet the standard when used on a minimum 1.4 acre parcels. Each of these technologies has successfully passed the piloting stage and has been permanently approved for residential use in the Pinelands Area. Commission staff has recently determined that the SeptiTech technology also meets the water quality standard when used on one acre parcels. Accordingly, staff has recommended that the Commission permanently approve the SeptiTech technology for use by residential on minimum one acre parcels.

Two pilot program technologies (Ashco RSFIII and Cromaglass) were eliminated from the pilot program, the reasons for which are detailed later in this report. Commission staff is currently recommending that the BioBarrier, Hoot ANR and Busse GT technologies also be removed from the pilot program. The basis for this recommendation is also detailed later in this report.

N.J.A.C 7:50-10.23(c) directs that this implementation report focus specifically on the BioBarrier, Busse GT, Hoot and SeptiTech treatment technologies (the technologies that are currently being piloted). While this report briefly discusses various aspects of each of the technologies that have previously participated in the pilot program, more detailed information on the program and a more thorough discussion of the permanently approved and eliminated technologies is available in the Commission's August 5, 2019 Annual Report, which is available at the link above.

Per N.J.A.C. 7:50-10.23(c)1-6, this report evaluates the four technologies that are currently being piloted with respect to the following:

1. The level of nitrogen in the effluent from each treatment technology (Note: 14 mg/L total nitrogen (TN) in treated effluent is required to meet Pinelands water quality standards for residential use on minimum one acre parcels);

2. The maintenance required for each technology to meet effluent requirements;

3. The cost of installing and maintaining each treatment technology;

4. The problems associated with the installation, operation and maintenance of each treatment technology;

5. The number of systems of each technology that have been authorized under the pilot program; and

6. Whether the pilot program, when viewed in its entirety, has served to further the purposes and objectives of the Pinelands Protection Act, the Federal Act and the CMP.

Table 1 identifies the current status and staff recommendations for each of the wastewater treatment technologies that are currently participating or previously participated in the pilot program.

Table 1. Status, minimum lot size, and staff recommendations for each treatment technology.

Technology	Status	Minimum Parcel Size Required (Acre)	Recommendation in this report	Basis for recommendation
Amphidrome	Permanently approved	1.0	No change in status	NA
Bioclere	Permanently approved	1.0	No change in status	NA
Fast	Permanently approved	1.4	No change in status	NA
BioBarrier	Piloted	2.2	Recommend removal from pilot program	Declining performance/not meeting water quality standards
SeptiTech	Piloted	1.0	Recommend permanent approval	Meeting water quality standards
Busse GT	Eligible for piloting	Not verified	Recommend removal from pilot program	No units sold in Pinelands Area since October 2011 piloting approval
Hoot ANR	Eligible for piloting	Not verified	Recommend removal from pilot program	No units sold in Pinelands Area since October 2011 piloting approval
Ashco RSF III	Removed from pilot program	3.2	No change in status	Technology removed from the pilot program due to lack of sales
Cromaglass	Removed from pilot program	3.2	No change in status	Technology removed from pilot program for not meeting water quality standards

Pilot Program Technologies Past and Present

Table 2 identifies the type of biological nutrient removal process employed by each technology and the median total nitrogen concentration in treated effluent.

Table 2. Microbiological treatment processes, and median effluent TN concentration of each of the pilot program technologies

Technology	Microbiological Treatment Type	Median [TN] mg/L (≤14.0 mg/L TN is required for use on a 1 acre parcel)
Amphidrome	Sequencing Batch Aerated Aggregate Filter (Attached Growth)	11.9
Ashco RSF III	Recirculating Sand Filter (Attached Growth)	N/A
Bioclere	Trickling Plastic Media Filter (Attached Growth)	11.2
BioBarrier	Membrane Bioreactor (Suspended Growth)	29.3
Busse GT	Membrane Bioreactor (Suspended Growth)	N/A
Cromaglass	Sequencing Batch Reactor (Suspended Growth)	31.5
FAST	Fixed-Film (Attached and Suspended Growth)	18.2
Hoot ANR	Activated Sludge (Suspended Growth)	N/A
SeptiTech (STAAR)	Fixed-Film Trickling Filter (Attached Growth)	11.6

Pilot Program Technologies Currently Under Evaluation

In October 2010, the CMP was amended to authorize additional, pre-screened technologies to participate in the pilot program. Eligibility was limited to technologies that had attained NSF Standard 245 certification and/or U.S. Environmental Protection Agency (USEPA) Environmental Technology Verification (ETV); each certification program evaluates a technology's ability to reduce nitrogen in wastewater.

Vendors of NSF Standard 245 and/or USEPA ETV certified technologies were invited to apply for participation in the pilot program. The Commission received applications from the vendors of the Septi-Tech, BioBarrier, Busse GT and Hoot ANR treatment systems, all of which were expected to produce final effluent TN concentrations on the order of 14 mg/L based upon evaluation by NSF for Standard 245 certification. Upon review of NSF's reported performance and cost data, the Pinelands Commission took action to authorize the use of these four technologies for participation in the pilot program in October 2011. Subsequently, the New Jersey Department of Environmental Protection (NJDEP) issued a generic Treatment Works Approval (TWA) to authorize Pinelands Area Health Departments to approve the four newly authorized treatment systems as well as those that were previously admitted into the pilot program.

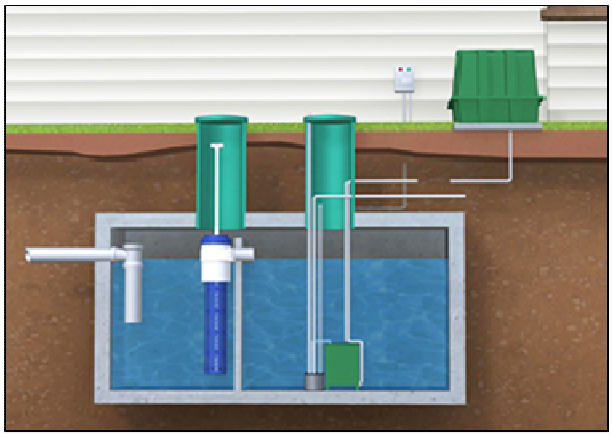
The SeptiTech technology is currently approved for use on 1.0 acre parcels based upon laboratory testing

of treated effluent.

The BioBarrier technology was downgraded in October 2016 from its original approval for use on 1.0 acre parcels and since that time is only authorized for use on minimum 1.7 acre parcels. Although recent testing of BioBarrier effluent indicates that it would meet Pinelands water quality standards only if used on minimum 2.2 acre parcels, rather than recommending another increase in the minimum lot size Commission staff is instead recommending that the technology be removed from the pilot program. The BioBarrier manufacturer instituted a moratorium on new sales in February 2015, prior to the Commission's imposition of the increased lot size requirement and began a program to identify and correct the cause for substandard performance. That troubleshooting program has not been effective at improving the nitrogen removal capability of the BioBarrier technology.

There are currently no Hoot ANR or Busse GT technologies operating in the Pinelands Area. While these technologies were authorized to participate in the pilot program in October 2011, because no units have been installed in the intervening 8 years, staff is recommending that these technologies be removed from the pilot program. Such action would open up opportunities for other technologies to participate in the program as the CMP sets a limit of no more than six participating technologies at any one time.

BioBarrier



As noted above, staff has recommended that the BioBarrier technology be removed from the Commission's pilot program due to its inability to meet Pinelands water quality standards on parcels that are smaller than 2.2 acres.

The BioBarrier MBR is a membrane bioreactor that combines activated sludge treatment processes with solids separation via membrane filter technology. The system employs flat sheet membranes with pore sizes ranging between of 0.02 to 1.4 µm. The membranes are housed in an aerated membrane cartridge which is submerged in the wastewater. The membranes provide a barrier that retains wastewater microorganisms within the treatment unit. The large mass of retained microbes provides an effective buffer against shock loadings to the system. The long microbial residence time in the treatment system allows the microorganisms to undergo endogenous respiration, reducing the total amount of solids produced by the treatment process.

The system consists of a tank with three compartments. The first compartment provides primary treatment – sedimentation and separation of floatables and solids, and is equipped with a proprietary outlet screening device. A solid wall separates the first compartment from the second, in which the system's nitrogen reduction capabilities may be enhanced under anoxic conditions. The third compartment, the "aeration/membrane zone", is separated from the anoxic zone by a baffle wall with openings between the two zones. The BioBarrier® Membrane module is located in the third compartment. Aeration is provided to the third compartment by a blower which serves two functions. First, the blower provides mixing of the wastewater and biomass to allow complete contact between the bacteria and organic material in the wastewater, while supplying oxygen that is critical to the process. Second, the positioning of the aeration under the membrane sheets helps to remove solids that collect on the surface of the sheets. The membranes sheets, having microscopic pore size openings, separate the water from the solids in the aeration zone. An effluent pump provides a slight negative pressure on the "clean" side of the membrane, pulling filtered water through the membrane. The solids that are sloughed by aeration and membrane cleaning are retained in the aeration compartment.

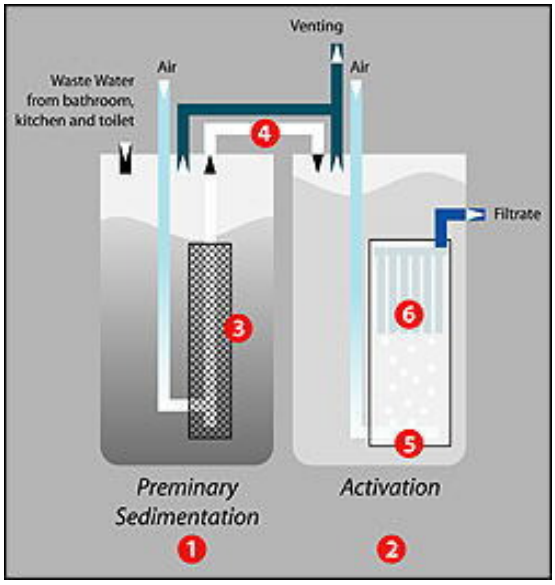
As illustrated in Table 3, one hundred ninety-five effluent samples were evaluated from thirteen BioBarrier systems through June 2019. TN concentrations for each system are represented by the sum of total Kjeldahl nitrogen, plus nitrite nitrogen, plus nitrate nitrogen. The BioBarrier technology produced a grand median TN concentration of **29.3** mg/L based upon all samples through June 5, 2019. This value continues a rising trend in total nitrogen effluent concentrations of 21.9 mg/L reported in 2017 and 24.4 mg/L reported in 2018. An advanced wastewater treatment technology must attain a grand median total nitrogen concentration that is less than or equal to 14.0 mg/L in order to meet Pinelands water quality standards when used to serve residential development on a minimum one acre parcel. As previously noted, the manufacturer of the BioBarrier technology instituted a voluntary moratorium in February 2015 on the sale of new BioBarrier units in the Pinelands. The technology's nitrogen removal capability has not improved since the Commission took action in October 2016 to increase the minimum required lot size from 1.0 acre to 1.7 acre **As a result, Commission staff has recommended that BioBarrier's participation in the pilot program be discontinued.**

Table 3. BioBarrier running median [TN] (mg L-1) by number of sampling events for each wastewater treatment system. The grand median, 25th percentile, 75th percentile, and number of systems sampled (n) per event are provided.

Total Nitrogen Running Median		Number of Sampling Events																			
Technology	System	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		Grand Median
BioBarrier	1	14.1	20.6	14.9	21.0	27.1	29.0	30.8	31.1	31.3	31.1	30.8	31.1	31.3	33.0	34.7	35.5	34.7	35.5		31.1
BioBarrier	2	13.8	12.1	12.6	13.2	12.6	11.5	12.6	13.2	13.8	13.2	13.8	15.7	17.5	19.1	20.6	23.6	26.6	31.8		13.8
BioBarrier	3	19.9	15.9	19.9	31.3	19.9	30.3	26.8	23.4	22.3	24.6	26.8	30.7	34.6	37.6	40.6	41.7	42.7			26.8
BioBarrier	4	20.4	21.9	23.4	25.8	23.4	25.8	28.2	25.8	27.5	25.6	27.5	27.9	28.2	28.8	29.3	28.8	28.2			27.5
BioBarrier	5	20.8	21.8	22.8	22.9	22.9	22.9	22.8	22.9	22.9	24.3	25.7	27.9	30.1	31.6	33.0	34.3	33.0			22.9
BioBarrier	6	18.9	28.4	32.0	27.5	32.0	32.8	33.6	32.8	32.0	32.8	33.6	35.7	37.8	40.4	42.9	43.7	44.4			32.8
BioBarrier	7	28.4	36.4	40.8	34.6	28.4	34.6	28.4	24.8	21.2	24.8	28.4	34.6	40.8							28.4
BioBarrier	8	13.3	25.8	38.3	25.8	13.3	22.4	31.1	31.3	31.1	31.3	31.4	34.9	38.3							31.1
BioBarrier	9	13.6	14.3	15.0	14.4	15.0	23.3	15.0	23.3	31.6	23.3	31.6	29.3	31.6	31.6	31.6	32.2	32.7	32.7	32.7	29.3
BioBarrier	10	11.8	10.0	8.1	8.9	9.6	9.7	9.8	10.8	11.8	12.7	13.6	16.5	19.4	20.1	23.5					11.8
BioBarrier	11	28.4	16.7	10.8	19.6	10.8	19.6	28.4	31.3	34.2	38.4	42.6	46.3	42.6	42.6						29.9
BioBarrier	12	33.1	19.6	33.1	33.3	33.4	33.3	33.1	30.7	33.1	33.3	33.1	30.7	33.1	33.3						33.1
BioBarrier	13	12.6	14.1	15.5																	14.1
Sample# Median		18.9	19.6	19.9	24.3	21.4	24.6	28.3	25.3	29.3	25.2	29.6	30.7	32.4	32.3	32.3	34.3	33.0	32.7	32.7	29.3
25th Percentile		13.6	14.3	14.9	18.3	13.1	21.7	20.9	23.2	22.0	24.1	26.5	27.9	29.6	29.5	27.9	30.5	30.5	32.2	32.7	23.6
75th Percentile		20.8	21.9	32.0	28.4	27.4	30.9	30.9	31.1	31.7	31.6	32.0	34.7	37.9	36.5	36.2	38.6	38.7	34.1	32.7	31.8
n		13	13	13	12	12	12	12	12	12	12	12	12	12	10	8	7	7	3	1	

Busse GT

As noted above, staff has recommended that the Busse GT technology be removed from the Commission's pilot program due to its lack of system sales in the eight years since being admitted into the program.



The Busse GT wastewater treatment system is a small-scale membrane bioreactor. The system provides treatment in a three-stage, four-tank process. Wastewater enters an intermittently aerated first tank and is then transferred by an airlift through a mesh filter to an identical second tank. Wastewater in the second tank is divided evenly between two membrane tanks, again with a screened airlift transfer. The membrane bioreactor tanks house 24 Kubota flat-sheet membranes. The Kubota membranes units are comprised of two sections: the lower section contains the air piping and the upper section contains the membrane panels. The membrane units are submerged in activated sludge within the reactor

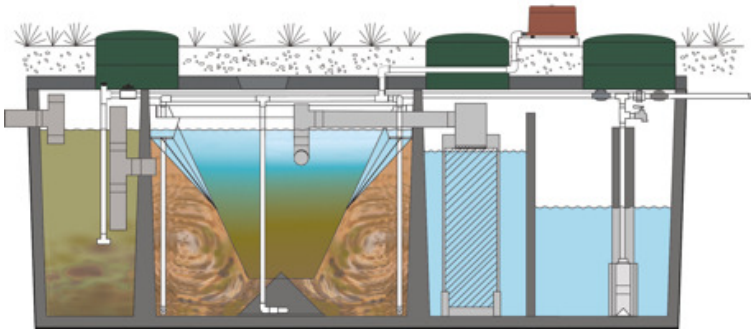
tanks. The tanks are aerated by coarse and fine bubbles that provide a cross flow of liquid over the surface of the membrane panels. Cross flow circulation reduces membrane fouling and provides oxygen for microbial degradation of wastewater organics. The liquid head above the membrane drives permeate from the wastewater mixture through the membrane, where it flows via a manifold through the tank wall and is discharged. A return sludge airlift is activated by a programmable logic controller and is controlled by level sensors located in tanks two through four. A third air pump provides aeration to the airlifts in the first two tanks.

The bioreactor provides an aerobic environment where microorganisms present in the wastewater remove soluble contaminants, using them as a source of energy for growth and production of new microorganisms. The organisms flocculate and form aggregations that further physically entrap particulate organic matter. The organic matter is attacked by extracellular enzymes that solubilize the solids to make them available to the microorganisms as a food source. The conversion of the organic matter from soluble to biological solids allows for removal of the organic matter by settling and filtration of the solids in the treatment process. As there are currently no Busse GT systems operating in the Pinelands Area, the Commission has no performance data to report at this time.

There have been no Busse GT systems installed in the Pinelands Area since being approved to participate in the pilot program eight years ago. Commission staff has recommended that Busse GT's participation in the pilot program be discontinued due to the lack of system installations. Removing the Busse GT technology from the pilot program would open up the opportunity for other technologies to participate, as the CMP limits the number of participating technologies to six at any one time.

Hoot ANR

As noted above, staff has recommended that the Hoot ANR technology be removed from the Commission's pilot program due to its lack of system sales in the 8 years since being admitted into the program.

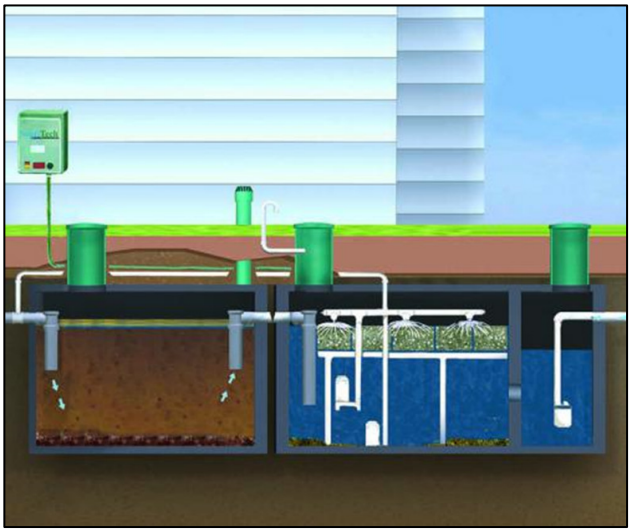


The Hoot ANR treatment system is an extended aeration/activated sludge treatment process coupled with anaerobic denitrification. The unit is comprised of five principal components, a Pretreatment Tank, Aeration Chamber, Clarifier, Media Tank and Final Clarifier/Pump Tank.

The Pre-Treatment tank provides separation and anaerobic digestion of influent solids and functions much like a septic tank by reducing up to 50% Total Settable Solids (TSS) and approximately 25% of Biochemical Oxygen Demand (BOD5). Liquid waste flows out of the pretreatment tank through a baffled outlet and into the aeration chamber. The activated sludge treatment process occurs in the aeration chamber through the introduction of oxygen into the mixed liquor to enable the conversion of soluble material into biomass. In addition, oxygen enables nitrifying bacteria to convert ammonia-nitrogen to nitrate-nitrogen. Wastewater then flow to a clarifier for additional solids settling. From the clarifier, wastewater is transferred to a media tank where an attached growth treatment process occurs. Here, a proprietary carbon source is added. In the presence of the supplemental carbon source, denitrifying bacteria release free nitrogen to the atmosphere. A final clarifier/pump tank constitutes the last treatment component before discharge to the soil absorption field. A portion of the daily flow of the system is recirculated from this chamber to the pre-treatment tank where it is reprocessed through the system. As there are currently no Hoot ANR systems operating in the Pinelands Area, the Commission has no performance data to report at this time.

There have been no Hoot ANR systems installed in the Pinelands Area since being approved to participate in the pilot program eight years ago. Commission staff has recommended that Hoot ANR's participation in the pilot program be discontinued due to the lack of system installations. Removing the Hoot ANR technology from the pilot program would open up the opportunity for other technologies to participate, as the CMP limits the number of participating technologies to six at any one time.

SeptiTech Technology



As noted above, staff has recommended that the SeptiTech technology be permanently approved for residential use on minimum one acre parcels in the Pinelands Area.

The SeptiTech wastewater treatment system is a two-stage treatment technology, based on a fixed film trickling filter, using a patented highly permeable hydrophobic media. The first stage of treatment occurs in the primary tank in which the solids are settled and partially digested. The second stage of the system is a processor that provides secondary wastewater treatment. Microorganisms present in the wastewater grow within the media, using nutrients and organic materials provided by the constant supply of fresh wastewater to form new cell mass. Air is drawn into the system via an air intake pipe at the top of the SeptiTech® System. Venturis located in the sprinkler head distribution piping aerate the wastewater sprayed onto the media. The system operates without a fan or compressor.

The SeptiTech system is designed to remove total nitrogen from wastewater by nitrification and denitrification. Nitrification occurs in the second stage of the system, where ammonia–nitrogen is converted to nitrite and nitrate (predominately nitrate), while denitrification occurs in the anaerobic/anoxic primary tank. Denitrification also occurs in a stacked media module that floats in the reservoir below the aerobic media.

Wastewater from the primary tank flows by gravity to the processor reservoir section, located below the filter media. The second and third pumps are used to return wastewater and solids from the reservoir back to the primary tank. The forth pump is used to discharge treated wastewater to the disposal location.

As illustrated in Table 4, sample results were evaluated from 35 SeptiTech systems to date. A total of 304 samples were collected from these systems producing a grand median total nitrogen concentration of 11.6 mg/L. The TN concentration for each SeptiTech system represents the sum of total Kjeldahl nitrogen, plus nitrite nitrogen, plus nitrate nitrogen. The 11.6 mg/L TN concentration value demonstrates that the technology has been shown to be capable producing treated effluent containing total TN at a concentration that is equal to or less than 14.0 mg/l as required to meet Pinelands water quality standards when used to serve residential development on a minimum one acre parcel.

Commission staff has recommended that the SeptiTech technology be advanced from the pilot program and authorized for permanent use on minimum one-acre parcels subject to the provisions of N.J.A.C 7:50-6.84(a)5iv(3)

Table 4. SeptiTech running median [TN] (mg L-1) by number of sampling events for each wastewater treatment system. The grand median, 25th percentile, 75th percentile, and number of systems sampled (n) per event are provided.

Total Nitrogen Running Median		Number of Sampling Events																
Technology	System	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Grand Median
SeptiTech	1	8.7	8.8	8.7	8.7	8.7	8.8	8.7	8.7	8.7	8.7	8.7	8.7					8.7
SeptiTech	2	13.8	15.0	13.8	11.9	13.2	11.6	11.3	11.5									12.6
SeptiTech	3	5.3	5.1	5.3	6.7	5.3	5.3	5.3	5.3									5.3
SeptiTech	4	8.3	19.1	9.0	9.4	9.0	8.8	9.0	8.8	8.8								9.0
SeptiTech	5	7.7	8.5	9.2	8.9	9.2	9.6	9.2	8.9	9.2	8.9	8.5						8.9
SeptiTech	6	7.5	15.6	11.9	17.8	12.4	12.2	11.9	10.8	9.7	8.6							11.9
SeptiTech	7	16.6	14.6	16.6	14.6	12.5	11.9	11.3	10.2	9.0	8.6							12.2
SeptiTech	8	17.0	11.1	7.0	10.8	10.0	8.5	10.0	10.4	10.0	10.4	10.8						10.4
SeptiTech	9	4.1	5.4	6.1	6.4	6.1	6.0	6.1	6.0	5.8	5.3	4.8	4.7	4.5				5.8
SeptiTech	10	29.0	26.7	24.3	22.3	20.3	17.0	20.3	17.3	20.3	18.7	17.1						20.3
SeptiTech	11	25.2	31.4	37.6	38.5	37.6	31.4	25.8	31.7	37.6	31.7	25.8						31.7
SeptiTech	12	10.7	16.0	21.3	16.0	10.7	12.0	13.0	11.9	12.9	13.0	13.0	13.1	13.2	13.1	13.0	13.1	13.0
SeptiTech	13	13.1	15.0	13.1	11.4	9.6	9.5	9.4	9.5	9.6	11.4	13.1	13.8	14.4	13.8	13.1	12.7	12.9
SeptiTech	14	18.7	13.4	13.4	13.5	16.1												13.5
SeptiTech	15	26.0	19.0	12.8	12.4	11.9	11.5	11.3	11.2	11.1	10.1	9.1						11.5
SeptiTech	16	19.6	18.8	18.0	16.1	16.5	15.4											17.3
SeptiTech	17	9.4	11.9	14.4	15.5	16.5	16.7	16.8	16.7	16.5	16.7	16.8						16.5
SeptiTech	18	24.2	27.8	24.2	17.7	20.1	21.0											22.6
SeptiTech	19	9.3	12.6	15.9	21.3	15.9	16.7	17.4	19.4	17.4	16.7							16.7
SeptiTech	20	21.9	22.4	21.9	18.1	16.2	16.1	16.0	15.2	14.3	13.7							16.2
SeptiTech	21	17.0	19.9	17.0	16.8	16.6												17.0
SeptiTech	22	15.2	14.1	13.9	14.5	14.3												14.3
SeptiTech	23	44.1	26.7	15.6	17.0	15.6												17.0
SeptiTech	24	7.5	6.6	5.7	5.9	6.1	6.1	6.1	6.0	6.1								6.1
SeptiTech	25	28.9	20.2	11.4	11.3	11.4	11.3	11.2	11.3	11.4								11.4
SeptiTech	26	9.2	8.7	8.1	8.7	9.2	8.7	8.1	8.7	9.2								8.7
SeptiTech	27	17.9	10.7	8.4	7.6	8.4	7.6	7.8	8.0									8.2
SeptiTech	28	5.5	6.7	7.3	7.6	7.3	7.2	7.1	7.2									7.2
SeptiTech	29	4.3	4.5	4.6	5.1	5.3	5.0	5.3	5.0									5.0
SeptiTech	30	7.4	8.6	9.7	9.8	9.7	9.8	9.8										9.7
SeptiTech	31	11.5	10.6	11.5	12.1	11.5	11.3											11.5
SeptiTech	32	16.4	12.2	8.1	8.1	8.0	8.0											8.1
SeptiTech	33	57.4	32.9	10.9	10.3	9.7												10.9
SeptiTech	34	28.5	16.4	9.5	10.0	9.5												10.0
SeptiTech	35	18.0	14.0	10.0														14.0
Sample# Median		15.2	14.1	11.5	11.6	11.1	10.5	9.9	10.2	9.9	10.9	11.9	10.9	13.2	13.4	13.1	12.9	**11.6**
25th Percentile		8.5	9.7	8.6	8.7	9.1	8.4	8.0	8.3	9.1	8.7	8.8	7.7	8.9	13.3	13.0	12.8	8.8
75th Percentile		20.8	19.0	15.8	16.1	15.8	13.0	12.2	11.7	14.0	15.9	15.9	13.3	13.8	13.6	13.1	13.0	13.9
n		35	35	35	34	34	28	24	23	18	14	10	4	3	2	2	2	

Alternate Design System Installations by Pinelands Management Area

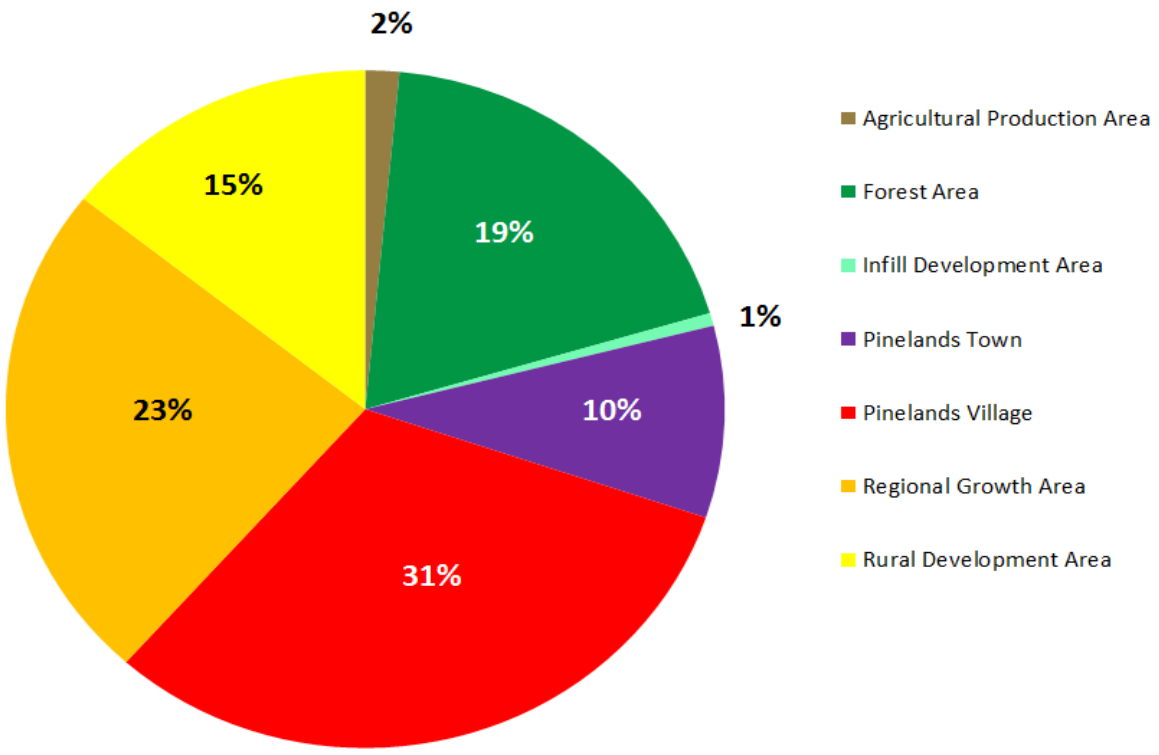
The Pinelands alternate design treatment systems have been installed in seven of the nine Pinelands Management Areas, with nearly 65 percent having been installed in the designated growth areas (Pinelands Towns, Pinelands Villages and Regional Growth Area).

Table 5 and Figure 1 show the distribution of systems by Pinelands Management Area.

Table 5. Numerical distribution of alternate design systems by Pinelands Management Area

Pinelands Management Area	No. of Installed Systems
Agricultural Production Area	5
Forest Area	62
Infill Development Area	2
Pinelands Town	30
Pinelands Village	105
Regional Growth Area	80
Rural Development Area	47
Total systems through June 2019	**331**

Figure 1. Percentage distribution of alternate design systems by Pinelands Management Area.



Pilot Program Evaluation

1. What is the effluent total nitrogen concentration [TN] in each treatment technology based on an evaluation of all monitoring results under this pilot program?

The CMP requires that each technology manufacturer arrange for the collection and analysis of treated effluent on a quarterly basis for the first three years that each system is in use (for a total of twelve samples per system). All samples must be analyzed by NJDEP certified laboratories employing analytical procedures approved by NJDEP's Office of Quality Assurance. Further, sample collection, transport and analysis must conform to the latest NJDEP Field Sampling Procedures Manual to ensure quality assurance and quality control in the collection and transport of samples, (i.e. chain of custody, sample preservation, etc.) All effluent samples are collected between the treatment unit and the soil dispersal field prior to the effluent being discharge to the soil absorption system. To permit the establishment of microbiological cultures necessary for the treatment process to develop and stabilize, sampling is not required during the first ninety days following system start-up.

Table 6 illustrates the effluent grand median total nitrogen concentration for each of the technologies currently being piloted and the minimum lot size required to meet Pinelands water quality standards as determined by application of the Pinelands Septic Dilution Model.

Table 6. Alternate design technology, effluent total nitrogen concentration, number of systems and number of samples, minimum lot size required to meet pinelands water quality standards and status on the pilot program.

Technology	Effluent [TN] mg/L	No. of Systems	No. of Samples	Min. lot size required (acres)	Pilot program status
BioBarrier	29.3	13	195	2.2	Recommend removal – insufficient TN removal
Busse GT	Not tested	0	0	unknown	Recommend removal – no systems installed after 8 years in the program
Hoot ANR	Not tested	0	0	unknown	Recommend removal – no systems installed after 8 years in the program
SeptiTech	11.6	35	304	1.0	Recommend permanent approval & graduation from pilot program

Table 7 illustrates the effluent grand median total nitrogen concentration for each of the technologies that were previously piloted and the minimum lot size required to meet Pinelands water quality standards as determined by application of the Pinelands Septic Dilution Model.

Table 7. Alternate design technology, effluent total nitrogen concentration, number of systems and number of samples, minimum lot size required to meet pinelands water quality standards and status on the pilot program.

Technology	Effluent [TN] mg/L	No. of Systems	No. of Samples	Min. lot size required (acres)	Pilot program status
Amphidrome	11.9	114	603	1.0	Permanently approved-graduated from program
Ashco RSF [III]	Not tested	0	0	3.2	Removed from program-no systems installed
Bioclere	11.2	80	268	1.0	Permanently approved-graduated from program
Cromaglass	31.5	59	559	3.2	Removed from program-insufficient TN removal
FAST	18.2	29	429	1.4	Permanently approved-graduated from program

2. What level of maintenance is required for each alternate design treatment technology to meet the required nitrogen targets?

The pilot program requires that a representative of the system manufacturer with expertise in the system be onsite to inspect all system components and to correct any construction, installation or operational problems that might be experienced during system startup. In addition, a representative of the design engineer must also be onsite to inspect the system at startup. After conducting onsite inspections, both the manufacturer and the design engineer must provide the Pinelands Commission with written certifications attesting that the installation of the system was properly completed.

Once each system is operating, an onsite audible and visual alarm and a remote telemetric alarm system monitor the treatment system's electrical and mechanical components to alter both the residents and the contracted service provider of any system operational problems in real time.

Each system is sold with a pre-paid five year maintenance contract which provides for the manufacturer's servicing agent to inspect the system at least once per year and to undertake any maintenance or repairs determined to be necessary.

Homeowners are provided with an operation and maintenance manual that outlines procedures for the proper use and care of the treatment system. Typical homeowner required maintenance involves pumping of septic tank solids at a recommended average frequency of once every three years, similar to the recommended pump out frequency for a conventional septic system.

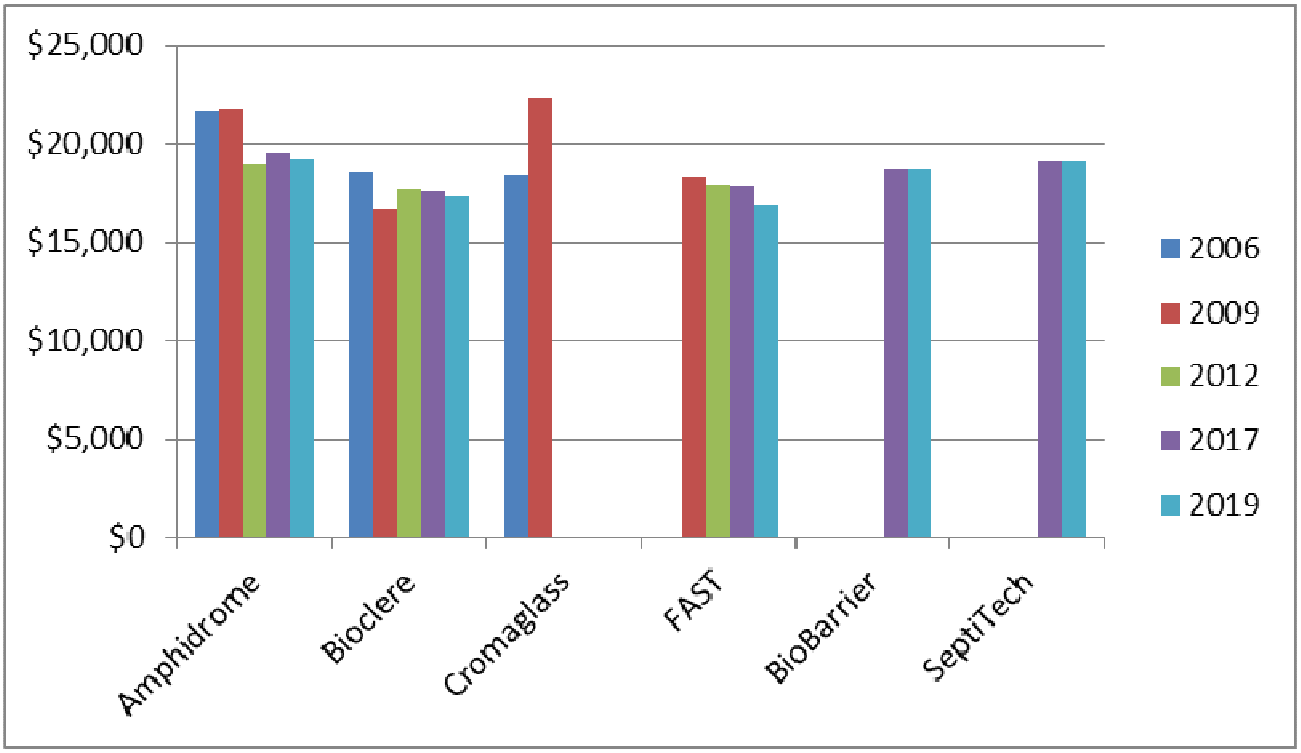
The required startup inspections and the annual operation and monitoring inspection by the serving agent have been largely successful in minimizing anything other than routine system maintenance (periodic pumping of solids). The five year warranty on each treatment system provides homeowners with protection from costs associated with unanticipated service calls and repairs during the warranty period. All of these features of the pilot program have kept the need for system maintenance to reasonable levels. Pursuant to NJDEP's regulations, homeowners are required to maintain operation and maintenance contracts on the treatment systems in perpetuity. However, a lack of universal enforcement of these NJDEP requirements by the county health departments remains a problem both in the Pinelands Area and statewide. The Commission's MIS office intends to develop a database system to help the county health departments better manage operation and maintenance contract renewals.

3. What is the cost of installing and maintaining each alternate design pilot program treatment system?

Equipment and system installation costs are reported to the Commission at the time of system start-up. The total cost of an onsite wastewater treatment system includes at least three separate components. These include the cost of the treatment equipment (with 5 year service package), the cost of the soil absorption (disposal field) system, and the cost of engineering, excavating, construction, electrical connections, permitting and other installation services. The system vendor provides the Commission with the cost of the equipment and the initial five year service contract. Other costs, such as engineering, permitting, inspection and construction are typically supplied by the homeowner or builder to the vendor who in turn provides that information to the Commission.

Figure 2 shows the change in equipment costs for the Amphidrome and Bioclere units as reported to the Commission in 2006, 2009, 2012, 2017, and 2019. This figure also shows the equipment costs for the Cromaglass units during the years 2006 and 2009, the last year that the Cromaglass system was installed in the Pinelands Area. Equipment costs are also provided for the FAST units purchased in 2009, 2012, 2017 and 2019. Equipment costs for the BioBarrier and SeptiTech units are provided only for 2017 and 2019 as neither system was installed in 2006, 2009 or 2012.

Figure 2. Average cost of wastewater treatment equipment (and 5 year service contract) for each of the pilot program technologies from 2006 through 2019 (as applicable).



With the exception of the Cromaglass technology, the cost for each of the pilot program technologies has remained relatively steady or has declined slightly during the period of the pilot program. Although the cost of Cromaglass units increased significantly from 2006 to 2009, no new system approvals were issued after the technology was suspended from the program in November 2006. Subsequently the technology was eliminated from the pilot program in September 2014.

Table 8 provides the average total cost to consumers purchasing and installing an advanced treatment system and effluent disposal field. These costs were compiled using information provided to the Commission by the

treatment system vendor and supplemented by the homeowner or builder.

Amendments to the NJDEP's septic system design standards (N.J.A.C 7:9A) that took effect in April, 2012 allow for a reduction in the required size of effluent fields where higher quality effluent is produced by alternative treatment units, including those that participate in the Commission's pilot program. These regulatory changes can reduce overall construction costs if design engineers incorporate smaller absorption fields into their design plans. In addition, because advanced treatment systems typically remove up to 98 % of total suspended solids (TSS) and biochemical oxygen demand (BOD), when properly maintained, the frequency of effluent disposal field repair or replacement is expected to be reduced.

Table 8. Average total reported cost of the pilot program systems including the cost of the treatment units, disposal fields, permitting, engineering and associated construction costs, current through June 2019. Cost information is derived from a variety of sources and should therefore be considered to be approximate

Name of Treatment System Technology	**No. of Systems included in this cost analysis**	**Average Reported Cost per Treatment Unit with 5 year warranty and 5 year operation and maintenance service.**	**Average Reported Cost for Engineering, Soil Absorption Field Installation, Electrical Connections, etc.** (1)	**Average Reported Total Cost of the Advanced Onsite Treatment Systems**
Amphidrome	76	$19,247	$12,075	$31,322
Bioclere	64	$17,384	$10,103	$27,487
Cromaglass	42	$23,553	$11,712	$ 35,265
FAST	29	$16,818	$11,514	$28,322
BioBarrier	13	$18,744	$10,031	$28,775
SeptiTech	32	$19,120	$9,234	$28,354
Busse GT (7)	N/A	unknown	N/A	N/A
Hoot ANR(7)	N/A	unknown	N/A	N/A

(1) Reported engineering and construction costs including soil and site suitability investigations (soil logs and "perc"/permeability tests), preparation of engineering plans, completion of NJDEP application forms, excavation for soil absorption system and tank placement, soil absorption system materials (suitable "K4" replacement soil, stone filter materials and lateral piping, or gravel free chambers, geotextile fabric), installation of all components, electrical connections, surveyor services, as-built plans, engineering inspections and as-built certifications.

The total average cost of each of the alternate design treatment technologies is approximately two times that of the average cost of a conventional (non nitrogen-attenuating) septic system. The purchase of a conventional system would not, however, include a five year operation and maintenance contract, 5 year warranty, and quarterly effluent sampling, nor would the conventional system provide enhanced wastewater treatment, expected to increase the life of the soil absorption field. It is noteworthy that in order to meet Pinelands water quality standards, conventional septic systems may only be used on minimum 3.2 acre parcels. In addition to providing enhanced levels of nitrogen, TSS and BOD removal, the pilot program systems may be used on parcels that are significantly smaller than 3.2 acres.

The cost of the initial five year warranty and operation and maintenance (O&M) contract is included in the total reported cost of the advanced treatment units. Upon expiration of the original five year O&M contract, contract renewal is required pursuant to NJDEP's regulations (N.J.A.C 7:9A-12.3 (a)). Those regulations state that the owner of an advanced wastewater treatment system must maintain a service contract with an authorized service provider throughout the life of the system. The cost to renew an O&M contract ranges between $350 and $400 per year with some firms offering a discount for multi-year contract renewals. These fees do not include septic tank pumping, the average cost of which is approximately $200 per 1000 gallons. Septic tank pumping is generally recommended at a frequency of once every three years. Therefore, the total annualized cost for O&M services and pumping ranges from $420 to $470 per year or approximately $35 to $40 per month.

The advantages of improved water quality, professional system maintenance and the ability to meet water quality standards in areas currently zoned for one-acre residential development supports the continuation of the Pinelands Alternate Design Wastewater Treatment Systems Pilot Program.

4) Are there problems associated with the installation, operation and maintenance of each technology? What is the frequency of such problems and what is the success of the measures typically taken to eliminate system problems?

The CMP requires each technology manufacturer to report the frequency and nature of system startup and operational problems. As noted in No. 2, above, a manufacturer's representative with expertise in system design, construction and operation and an inspector from the design engineer's office must be present during system startup to identify and correct any construction, installation or operational problems prior to the system being put into operation. This practice has eliminated construction installation errors from going undetected and has resulted in eliminating system installation problems.

Operational problems are rare and when they have occurred they are generally attributable to nearby lightning strikes. This type of problem is not unique to advanced wastewater systems; nearby lightning strikes sometimes affect home electronics, well pumps and conventional septic system effluent pumps. In these events, service providers have been promptly notified of the situation via system alarms and have successfully replaced damaged system components at no cost to system owners during the initial five year warranty period.

In the case of the SeptiTech technology, the Commission's requirement for quarterly effluent sampling and analysis was critical in identifying a software programming error that affected early system installations. This programming error resulted in systems being installed without the denitrification (anaerobic) cycle being activated. These systems were incorrectly programmed to operate only in an aerobic mode, reducing TSS and BOD but not total nitrogen. Once the programming error was detected through the Commission's effluent monitoring program, the manufacturer reprogrammed all previously installed systems and has ensured that all future systems are properly programmed.

In general, the pilot program alternate design systems have not exhibited breakdowns at a frequency that is any greater than is typical of onsite systems that incorporate effluent pumps (such as pressure dosing or gravity dosing) which are often used to overcome shallow water table conditions or grade limitations.

5) What is the total number of systems of each technology that have been authorized under the pilot program?

Table 9. Total number of pilot program wastewater treatment system installations by year of installation (through June 2019).

Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total Installed
Amphidrome	7	10	10	27	12	7	5	8	4	5	1	1	4	2	5	6	114
Bioclere	0	2	11	9	7	9	6	5	5	5	8	4	4	1	1	3	80
Cromaglass	0	19	24	3	6	4	3	0	0	0	0	0	0	0	0	0	59
FAST	0	0	0	0	2	5	3	3	3	5	2	2	0	0	3	1	29
SeptiTech	Admitted into pilot program in 2011								0	0	3	9	11	7	5	1	36
BioBarrier	Admitted into pilot program in 2011								0	0	5	7	0	0	1	0	13
Busse GT	Admitted into pilot program in 2011								0	0	0	0	0	0	0	0	0
Hoot ANR	Admitted into pilot program in 2011								0	0	0	0	0	0	0	0	0
Total	7	31	45	39	27	25	17	16	12	15	11	7	8	3	9	10	331

As shown in Table 9, there were three hundred thirty-one alternate design systems installed and operating in the Pinelands Area through June 2019. There are more Amphidrome and Bioclere systems in operation in the Pinelands largely due to those technologies' early entry into the pilot program. The FAST and SeptiTech technologies entered the pilot program later but, like Amphidrome and Bioclere, are developing a well-established network of designers, installer and service providers in the Pinelands.

6. Has the pilot program, when viewed in its entirety, served to further the purposes and objectives of the Pinelands Protection Act, the Federal Act and this Plan?

The pilot program has demonstrated that reliable small-scale advanced wastewater treatment technologies are available for residential use which, with proper installation, operation and maintenance, can achieve substantial compliance with the purposes and objectives of the Pinelands Protection Act, the Federal Act and the CMP.

The pilot program has enabled the installation of more than 330 alternate design treatment systems, representing six advanced onsite treatment technologies, during the period of August 2002 through June 2019. The effluent testing requirements of the pilot program have demonstrated that three of these technologies are capable of meeting the rigorous groundwater quality standards of the CMP when used on one acre parcels and one technology was demonstrated to meet the water quality standard when used on 1.4 acre parcels. The pilot program has also revealed that two of the piloted treatment technologies are incapable of achieving compliance with the Pinelands water quality standards. One of those technologies (Cromaglass) was eliminated from the pilot program in 2014 and the other (BioBarrier) is currently proposed to be eliminated.

By identifying wholly compliant (Amphidrome, Bioclere and SeptiTech), partially compliant, (FAST), and non-compliant technologies (Cromaglass and BioBarrier), the pilot program has fulfilled one of its original objectives, that being to independently evaluate nitrogen removal capabilities under real world conditions. The pilot program has provided the Commission with the ability to identify technologies that are capable of meeting Pinelands water quality standards and to calculate the minimum parcel size required when these technologies are relied upon to meet the standards. While some jurisdictions nationwide have opted to approve nitrogen attenuating onsite wastewater treatment technologies based on third party certifications alone (e.g. NSF Standard 245), the Commission's decision to evaluate technologies on the basis of their performance in the pilot program has proven to be a more prudent approach, with some technologies meeting or exceeding expectations and others not living up to the results reported by third party certifying organizations.

Conclusions and Recommendations

1. The continued use of advanced onsite treatment technologies is essential to the efficient use and

orderly development of designated growth areas of the Pinelands as well as other areas in which residential development is permitted on lots that are smaller than 3.2 acres.

The pilot program provides a means to test whether select onsite wastewater technologies can be maintained and operated to meet the water quality standards of the CMP in a manner that a homeowner can reasonably be expected to follow. The program has been successful in identifying several advanced treatment technologies (Amphidrome, Bioclere, FAST, and SeptiTech) that can be expected to achieve compliance with Pinelands water quality standards when used at appropriate densities as established through the Pinelands septic dilution model and land use zoning requirements. Each of these systems has been demonstrated to be reliable and effective when maintained in accordance with NJDEP's operation and maintenance requirements.

2. The CMP enables the removal of individual technologies from the pilot program if it's determined that the pilot program has not been implemented relative to those technologies. Such lack of implementation applies to both the Busse GT and Hoot ANR technologies. Each was originally authorized to participate in the pilot program in September 2011. Neither technology has been installed in the 8 years since being authorized for use. As a result, staff has recommended that the Busse GT and Hoot ANR technologies be eliminated from the program. The Commission took similar action when it eliminated the Ashco RSF ^{III} in December 2007 after there were no Ashco systems installed in the Pinelands Area during the four year period following its admission into the pilot program in May 2003.

3. The CMP also provides for a technology to be removed from the pilot program if it's determined that the technology has not been successful in meeting Pinelands water quality standards. Staff has recommended that the BioBarrier system be removed from the pilot program for this reason. The BioBarrier was authorized for use on minimum one acre parcels in September 2011. In October 2016, the Commission increased the technology's minimum lot size to 1.7 acres based upon effluent monitoring. In February 2015, the technology manufacturer instituted a voluntary moratorium on new system sales and sought to identify and correct substandard performance. In spite of the company's troubleshooting efforts, effluent data has exhibited a trend toward higher levels of TN in treated effluent. Based upon the latest data, the BioBarrier would need to be installed on minimum 2.2 acre parcels to meet Pinelands water quality standards.

   Rather than recommending another increase in the minimum required parcel size, Commission staff has recommended that BioBarrier technology be eliminated from the pilot program. The Commission took similar action in September 2014 when it eliminated the Cromaglass technology from the pilot program after the manufacturer was unable to improve the technology's nitrogen removal capabilities.

4. The CMP limits the number of technologies that may be piloted; no more than six technologies may participate in the pilot program at one time. The Amphidrome, Bioclere and FAST technologies previously graduated from the pilot program. Staff is currently recommending that SeptiTech also advance beyond the piloting stage and graduate from the program. These graduations, coupled with the prior removal of the Ashco and Cromaglass technologies and the current recommendation to remove BioBarrier, Busse GT and Hoot ANR, create an opportunity for the Commission to introduce up to six new prescreened nitrogen attenuating treatment technologies to the pilot program.

Staff recommends that up to six new NSF Standard 245 and/or USEPA ETV certified technologies be recruited to participate in the pilot program beginning in 2020. Introducing new technologies to the program should lead to increased competition among the system vendors and may lead to continued price stability and potential cost reductions.

5. N.J.A.C. 7:50-10.23(c) and (d) currently specify that the Executive Director must report on the pilot program relative to any USEPA ETV or NSF Standard 245 technologies by November 5, 2017, unless the number if monitoring events for such technologies is inadequate, in which case the review is to be done by November 5, 2019. Commission staff recommends that the Commission amend these two CMP sections so that the next report on any new pilot program technologies will be due in 2025, with a possible extension to 2027 if necessary.

6. Because advanced treatment systems are technologically sophisticated, care must be taken to properly operate and maintain them on a long-term basis. In 2012, NJDEP significantly enhanced its rules by requiring that all advanced treatment systems, including Pinelands alternate design treatment systems, be professionally maintained in perpetuity. Commission staff issues semi-annual notices to the O&M service providers reminding them of their obligation, under NJDEP's rule, to notify the health departments when an O&M contract has expired if it was not renewed. Notwithstanding the adoption of these much needed rules; lack of enforcement of the rules by the Pinelands Area county health departments remains a problem.

   Commission staff works closely with each of the county health departments in their processing of all septic system permit applications, with additional measures taken for alternate design systems. These additional measures include ensuring that design engineers and the system vendors certify that each system was properly designed and constructed, that the appropriate Deed Notices were filed to alert current and future owners of the special O&M obligations applicable to these systems, and that requisite O&M contracts are in place before the health departments allow occupancy of residences served by these systems.

   Readers are invited to direct all inquiries related to the Pinelands Alternate Design Treatment Systems Pilot Program to Ed Wengrowski, Environmental Technologies Coordinator, at ed.wengrowski@pinelands.nj.gov. or 609-894-7300.