PROJECT DESIGN AND SAMPLING PLAN

PFAS in Wastewater *Characterization and Fate*

Department of Natural Resources and Environmental Control

Division of Water

89 Kings Highway
Dover, DE 19901

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Revision 03

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1.0 INTRODUCTION

The Delaware Department of Natural Resources and Environmental Control (DNREC), Division of Water (DOW) Project Design and Sampling Plan for PFAS in Biosolids was prepared in September 2022, and the project is currently in process (second round of sampling was completed as of March 15, 2023). This document outlines the second phase of the PFAS study by addressing the rest of the components of the wastewater stream, i.e., influent, effluent, discharge receiving media, and post-discharge monitoring. For background information on DNREC-DOW PFAS study please refer to the Project Design and Sampling Plan for PFAS in Biosolids.

Discharges from wastewater treatment facilities can be categorized in two ways, either by the receiving media or the source of the wastewater. Receiving media can be surface water bodies (rivers, bay, or ocean) and are classified as "Surface Water Discharges", or wastewater applications to the land surface and subsurface which ultimately reaches the groundwater or "Groundwater Discharges". There are three classifications of wastewater sources, municipal, industrial/commercial, or residential. Industrial/commercial wastewater discharges are from industrial and commercial sources which may contain pollutants at levels that could affect the quality of receiving waters or interfere with publicly owned treatment works that receive those discharges. Municipal wastewater may be a combination from residential, businesses and industrial sources. Residential or domestic wastewater originates from activities such as restroom usage, bathing, food preparation and laundry.

For this project, receiving media are used as the primary classification followed by wastewater sources as the secondary classification. **Section 2.0** presents descriptions of selected surface water discharge facilities and then the sampling plan for each facility; **Section 3.0** presents selected groundwater discharge facilities and then sampling plan for each facility; **Section 4.0** discusses quality assurance and quality control; **Section 5.0** shows the tentative project schedule, and; **Section 6.0** summarizes the proposed activities.

A total of 15 wastewater treatment and disposal facilities (7 surface water discharge and 8 groundwater discharge) have been selected for this study. Figure 1.1 shows the locations of selected facilities. Detailed discussions on these facilities are presented in the following sections.

Figure 1.1 Locations of Wastewater Treatment and Disposal Facilities Selected for PFAS Study

2.0 SURFACE WATER DISCHARGES

2.1 Facility Description

Seven surface wastewater discharge facilities were selected for this wastewater PFAS study (Table 2.1 and see Figure 1.1 for regional locations).

Facility Name	Wastewater Source	Discharge Rate*
City of Wilmington	Municipal	66.1 MGD
Kent County	Municipal	13.2 MGD
City of Rehoboth Beach	Municipal	1.3 MGD
Middletown-Odessa-Townsend Regional	Municipal	0.7 MGD
City of Seaford	Municipal	1.3 MGD
INV Performance Materials	Industrial	2.3 MGD
Perdue Foods	Industrial	1.3 MGD

* Actual discharges in 2021 (except INV which is permitted discharges); MGD = million gallons per day

Table 2.1 Surface water discharge facilities selected for PFAS in wastewater study

The following sections present brief descriptions on each facility.

2.1.1 City of Wilmington Wastewater Treatment Facility

- NPDES Permit Number: DE0020320
- Permittee: City of Wilmington
- Operator: Operations Management International, Inc.
- Facility Location: E. 12th Street & Hay Road, Wilmington, DE 19809
- Outfall 001 Coordinates: 39°43’51” N; 75°30’21” W
- Operational History: Prior to 1998
- Discharge Description: The facility discharges treated wastewater from municipal and commercial/industrial sources; the facility operates/implements a pretreatment program.
- Facility Description: The wastewater treatment facility (WWTF) consists of headworks (including screening and grit removal systems), four primary clarifiers, eight activated sludge basins, eight secondary clarifier basins, chlorine contact basin, and biosolids handling system.

- Receiving waters: Delaware River (Zone 5)
- 2021 Discharge: 66.1 MGD

Figure 2.1 Location and layout of the Wilmington WWTF

2.1.2 Kent County Regional Wastewater Treatment Facility

- NPDES Permit Number: DE0020338
- Permittee: Kent County Levy Court
- Operator: Kent County Department of Public Works
- Facility Location: 139 Milford Neck Road, Milford, DE 19963
- Outfall 001 Coordinates: 38°59’36.7” N; 75°26’14.4” W
- Operational History: Prior to 1988

- Discharge Description: The facility discharges treated wastewater from municipal and commercial/industrial sources; the facility operates/implements a pretreatment program.
- Facility Description: The WWTF consists of headworks (including fine screening and grit removal systems), extended aeration basins with rolling oxic and anoxic zones for biological nutrient removal (BNR), ferric chloride injection for phosphorous reduction, secondary clarifiers (up to six available), sand filtration system, UV disinfection system (with 12 channels available).
- Receiving waters: The Gut, a tributary to the Murderkill River.
- 2021 Discharge: 13.2 MGD

Figure 2.2 Location and layout of the Kent County WWTF

2.1.3 City of Rehoboth Beach Wastewater Treatment Facility

- NPDES Permit Number: DE0020028
- Permittee: City of Rehoboth Beach
- Operator: Rehoboth Beach Wastewater Department
- Facility Location: 2-12 Bay Rd, Rehoboth Beach, DE 19971
- Outfall 002 Coordinates: 38°43.787' N; 75°03.505' W [Ocean Outfall]
- Operational History: Prior to 1986
- Discharge Description: The facility discharges treated wastewater from municipal and commercial sources; there is no pretreatment program.
- Facility Description: The WWTF consists of headworks (including bar screen and grit removal systems), two emergency diversion tanks, two total-barrier oxidation ditches, chemical injection for phosphorus removal, two secondary clarifiers, filtration system, two chlorination/dichlorination tanks, two post-aeration tanks, and biosolids handling system.
- Receiving waters: Atlantic Ocean
- 2021 Discharge: 1.3 MGD

Figure 2.3 Location and layout of the Rehoboth Beach WWTF

2.1.4 Middletown-Odessa-Townsend (M-O-T) Regional Wastewater Treatment Facility

- NPDES Permit Number: DE0050547
- Permittee: New Castle County
- Operator: NCC Department of Special Services
- Facility Location: 810 Old Corbit Road, Odessa, DE 19730 (39.453147, -75.641358)
- Outfall 001 Coordinates: 39°27'16.2" N; 75°38'53.5" W
- Operational History: Prior to 1986
- Discharge Description: The facility discharges treated wastewater from municipal and commercial sources; no pretreatment program.
- Facility Description: The WWTF consists of drum screens, equalization (EQ) basin, two-train sequencing batch reactor (SBR) treatment system, cloth filtration system, ultraviolet (UV) disinfection system, and biosolids handling system.
- Receiving waters: Appoquinimink River (a Tributary to Zone 5 of the Delaware River)
- 2021 Discharge: 0.7 MGD

Figure 2.4 Location and layout of the M-O-T Regional Wastewater Treatment Facility

2.1.5 City of Seaford Wastewater Treatment Facility

- NPDES Permit Number: DE0020265
- Permittee: City of Seaford
- Operator: Seaford Public Works Department
- Facility Location: 403 Nanticoke Ave, Seaford, DE 19973
- Outfall 001 Coordinates: 38°38'4" N; 75°37'2" W
- Operational History: Prior to 1986
- Discharge Description: The facility discharges treated wastewater from municipal and commercial/industrial sources. The facility receives and treats leachate from the Southern Solid Waste Management Landfill in Georgetown; the facility has a pretreatment program.
- Facility Description: The WWTF consists of headworks (including mechanical screen and grit removal system), one primary clarifier (a second available if needed), one flow equalization tank, two anoxic basins, four oxic basins, alum added for phosphorus removal, two secondary clarifiers, two traveling-bridge sand filters, one double-sided chlorine contact chamber and biosolids handling system.
- Receiving waters: Nanticoke River
- 2021 Discharge: 1.3 MGD

Figure 2.5 Location and layout of the City of Seaford Wastewater Treatment Facility

2.1.6 INV Performance Material's Seaford Nylon Plant

- NPDES Permit Number: DE0000035
- Permittee: INV Performance Materials, LLC
- Operator: INV Performance Materials, LLC
- Facility Location: 25876 DuPont Road, Seaford, DE 19973
- Outfall Coordinates: Multiple as shown in Table 2.2

Outfall	Description
001	Air compressor condensate, non-returned steam condensate, non-contact cooling water, and storm water. (38.00o 37.00' 52.02" N, 75.00o 37.00' 27.35" W)
002	Drinking water tank overflow (unused groundwater), non-returned steam condensate, reverse osmosis reject water, and boiler blow-down. (38.00o 37.00' 49.10" N, 75.00o 37.00' 30.39" W)
003	Non-returned steam condensate, non-contact cooling water, and storm water. (38.00o 37.00' 47.38" N, 75.00o 37.00' 32.02" W)
004	Non-returned steam condensate, non-contact cooling water, and storm water. (38.00o 37.00' 43.74" N, 75.00o 37.00' 36.25" W)
005	Sanitary wastewater, process finish wastewater and storm water. (38.00o 37.00' 49.25" N, 75.00o 37.00' 27.09" W)
006	Same as Outfall 005, but prior to UV disinfection. (38.00o 37.00' 48.85" N, 75.00o 37.00' 26.37" W)
008	Diverted storm water. (38.00o 37.00' 43.94" N, 75.00o 37.00' 30.91" W)
010	River intake (primarily for on-site firefighting operations).
011	Overall combined discharge including all internal outfalls and storm water from site. (38.00o 37.00' 27.32" N, 75.00o 37.00' 43.69" W)

Table 2.2 Descriptions of outfalls at the INV's Seaford Nylon Plant

- Operational History: Prior to 1988
- Discharge Description: The facility discharges non-contact cooling water, treated process and sanitary wastewater, and storm water.
- Facility Description: The WWTF consists of one flow equalization tank, two aeration basins, one secondary clarifier, two sand filters, and one UV disinfection system. The plant primarily manufactures Nylon 6,6 Staple fiber. In 2009, certain operations at the facility

were idled or shut down, including the nylon polymerization, carpet fiber processes and power generation. Since June 2009, the facility has used polymer made at other INV Performance Material, LLC sites for fiber production.

- Receiving waters: Nanticoke River
- Permitted Flows: Outfalls 001, 002, 003, 004 = 2.225 MGD (Daily AVG)
  Outfall 005 = 0.133 MGD (Daily AVG)

Figure 2.6 Location and layout of the INV Performance Material's Seaford Nylon Plant

2.1.7 Perdue Foods, LLC

- NPDES Permit Number: DE0000469
- Permittee: Perdue Foods, LLC
- Operator: Perdue Foods, LLC
- Facility Location: 20621 Savannah Road, Georgetown, Delaware 19947
- Outfall 002 Coordinate: 38.702172 N; -75.382675 W
- Operational History: 1975
- Discharge Description:
    - Outfall 002 - Effluent from the wastewater treatment system, including:
        - process wastewaters from first processing operations (receiving, killing, scalding, picking), second processing operations (evisceration, chilling), and further processing operations (cutup, boneless, thinslice);
        - plant sanitation wastewater;
        - sanitary wastewater;
        - boiler blowdown (0.035 MGD);
        - process area storm water (includes storm water runoff from the following areas: processing building roofs, live receiving area, offal area, yard wash down, refrigerated box trailer parking pads, truck wash, trailer drippings, driveways, live haul scale, vehicle refueling area, and raw waste lift station); and,
        - feed mill boiler blowdown (0.003 MGD) from the Perdue Feed Mill, in Bridgeville.
    - Outfall 004 - Storm Water discharge from a grassed area, not considered for this study.
- Facility Description: This facility is a poultry processing plant. Operations include receiving of live poultry and the slaughter, eviscerating, chilling, and packaging of fresh poultry followed by shipment to northeast markets. The wastewater treatment system consists of: screening, anaerobic lagoons, activated sludge (2-cell parallel aerobic/anoxic system), chemical precipitation using alum for phosphorus removal, clarification, and ultraviolet (UV) disinfection. Sand filtration prior to the UV disinfection is not used because the plant meets the TSS permit limits. Sanitary wastewater is treated in a batch

aerobic treatment system (sequence batch reactor – SBR) and is then pumped to the ultraviolet disinfection unit. Waste activated sludge from the treatment facility is aerobically digested, gravity thickened, dewatered by belt filter press, and then hauled by a contractor for ultimate disposal by land application. .

- Receiving waters: Savannah Ditch, Georgetown
- Permitted Flow: 1.3 MGD (2021 Daily AVG)

Figure 2.7 Location and layout of the Perdue Foods Wastewater Treatment Plant

2.2 Sampling from Surface Water Discharge Facilities

For this phase of study, influent (just before any treatment) and effluent (ready to be discharged) at each wastewater treatment facility (WWTF) listed above will be sampled. Once facilities for the next phase of study are identified, additional sampling at different treatment stages may be considered. Note that multiple effluent outfalls may exist at a single facility, sampling should be conducted from the wastewater outfall (not stormwater-only outfall). For example, Outfall 002 at the Perdue Foods facility should be sampled instead of Outfall 004, which discharges stormwater only.

At INV Performance, "influent" is sourced from unused groundwater, however it will still be sampled to document the presence or absence of PFAS in the source water. Note that effluent sample will be collected from Outfall 005 at this facility.

Quarterly sampling from each facility will be conducted to observe potential seasonal variations of the wastewater.

Samples will be named in the following format: *Facility Code*-IF or EF(*Quarter*), where Facility Code is WM=Wilmington, KC=Kent County, RB=Rehoboth Beach, MOT=MOT, SF=Seaford, INV= INV Performance, and PF=Perdue Foods; IF= influent, EF=effluent; and *Quarter* is the number of quarterly sampling event. For example, **MOT-EF1** will be the effluent sample collected from the M-O-T Regional Wastewater Treatment Facility during the first (quarter) sampling event.

3.0 GROUNDWATER DISCHARGES

3.1 Facility Description

Two types of groundwater discharge facilities are selected for this study: spray (treated wastewater applied over crops/grass fields), and rapid infiltration basins (RIB), where treated wastewater is discharged directly into the artificially constructed soil basins.

Eight wastewater treatment and groundwater discharge facilities are selected for this study and Table 3.1 presents a summary of these facilities (see Figure 1.1 for regional locations).

Facility Name	Wastewater Source	Discharge Rate*
Town of Middletown (Spray)	Municipal	2.39 MGD
Town of Middletown (RIB)	Municipal	0.47 MGD
Sussex Regional Recharge Facility (Spray)	Industrial	1.04 MGD
James Thompson (Spray)	Industrial	0.03 MGD
Beaver Creek (RIB)	Residential	0.14 MGD
Angola Beach & Estates (Spray)	Residential	0.09 MGD
Baywood Country Club (Spray; Golf Course)	Residential	0.05 MGD
Stonewater Creek (RIB)	Residential	0.34 MGD

* Actual discharges in 2022 (Stonewater discharge is from 2021); MGD = million gallons per day

Table 3.1 Groundwater discharge facilities selected for PFAS in wastewater study

3.1.1 Town of Middletown Wastewater Treatment Facility (Spray)

- OWTD-Spray Permit Number: 359298-13
- Permittee: Town of Middletown
- Operator: Artesian Wastewater Management, Inc.
- Facility Location: 1400 Industrial Dr, Middletown, DE 19709 (WWTF)
- Coordinates:
    - 39.435384448484605, -75.72695311486525 (WWTF)
    - 39.41259805838517, -75.7368827118416 (Ford Farm)
    - 39.42396090062268, -75.74428953750476 (Von Croy Farm)
    - 39.42525939323299, -75.7492799519701 (Charles E. Price Memorial Park)

- Operational History: Prior to 2001
- Discharge Volume: 2,388,845 GPD (2022 data)
- Discharge Description: The treated effluent is discharged via center pivot irrigation to the Von Croy farm (114 acres) or Ford farm (93 acres) or to solid set irrigation at the Charles E. Price Memorial Park (77 acres).
- Facility Description: Municipal, commercial, and industrial wastewater is treated in a WWTF that consist of one (1) two-celled aerated treatment lagoon system, one (1) polishing/storage lagoon, three (3) chemical injections systems (chlorine for algae management, and polymer and alum (aluminum sulfate) for coagulation, two (2) floculation/filtration systems, one (1) storage lagoon, and one (1) sodium hypochlorite disinfection system.
- Location map (Figure 3.1)

Figure 3.1 Location and Layout of the Middletown Spray and RIB Facilities

3.1.2 Town of Middletown Wastewater Treatment Facility (RIB)

- OWTD- RIBs Permit Number: 359298-15
- Permittee: Town of Middletown
- Operator: Artesian Wastewater Management, Inc.
- Facility Location: 563 Green Giant Rd, Townsend, DE 19734 (Tertiary System & RIBs)
- Coordinates: 39.40866608887651, -75.7316994640431 (RIBs)
- Operational History: Prior to 2018
- Discharge Volume: 473,935 GPD (2022 data)
- Discharge Description: The treated effluent is discharged to 18 RIBs with one RIB removed from the dosing sequence to allow for extended drying time and/or maintenance. The dosing cycle also includes a minimum 72 hour drying period.
- Facility Description: Municipal, commercial, and industrial wastewater is treated in a WWTF that consist of one (1) two-celled aerated treatment lagoon system, one (1) polishing/storage lagoon, three (3) chemical injections systems (chlorine for algae management, and polymer and alum (aluminum sulfate) for coagulation, two (2) floculation/filtration systems, one (1) storage lagoon, and one (1) sodium hypochlorite disinfection system. Treated effluent undergoes advance treatment using a tertiary biological treatment system utilizing Entex Webitat modules to reduce the Total Nitrogen concentration further. A Rapid Infiltration Basin (RIB) system, consisting of 21 RIBS, also located on the Ford Farm. The Town has an Operation Permit for 18 RIBs. The additional RIBs are constructed; however, they are not being used at this time. The Design Engineer has not submitted a Construction Inspection Report that certifies that the construction is complete, and the Town has not requested a permit amendment to include the additional RIBs for disposal.
- Location map (see Figure 3.1)

3.1.3 Sussex Regional Recharge Facility (Spray)

- OWTDS-Spray Permit Number: 359288-02
- Permittee: Artesian Wastewater Management, Inc.
- Operator: Artesian Wastewater Management, Inc.

- Facility Location: The Sussex Regional Recharge Facility is located on Sussex County Tax Map/Parcel Number: 2-35 6.00 28.09 along Route 30 approximately 4,000-ft north of the intersection of Route 16 and Route 30. Also known as ANSRWRF.
- Coordinates: 38.79827657150286, -75.34186095840444
- Operational History: Constructed in 2021
- Discharge Volume: 2.0 MGD
- Discharge Description: SRRF is currently authorized to receive treated poultry processing wastewater (treated effluent) from the Allen Harim Foods Harbeson Processing Facility's wastewater treatment system. The poultry processing facility's wastewater treatment system is owned by Allen Harim Foods, LLC and operated in accordance with State Permit No. 597261-01.
- Facility Description: Treated effluent is stored (at SRRF) in a synthetically lined lagoon prior to being discharged via spray irrigation to approximately 1,714 acres of agricultural fields designated as Fields F (to the north of the lagoon) and G (to the south of the lagoon). Fields D & E are not yet authorized to receive flow.
- Location Map (Figure 3.2)

Figure 3.2 Location of the Sussex Regional Recharge Facility (SRRF)

3.1.4 James Thompson and Company (Spray)

- OWTDS-Spray Permit Number: 359148-04
- Permittee: James Thompson and Company, Inc.
- Operator: James Thompson and Company, Inc.
- Facility Location: 301 S. Church Street, Greenwood, DE 19950
- Coordinates: 38.7993242363773, -75.59703743904713
- Operational History: Constructed in 1992
- Discharge Volume: 27,694 GPD (2022 data)
- Discharge Description: The facility manufactures finished cotton goods. The spray permit authorizes the land application of screened wastewater from fabric finishing, fabric dying, fabric rinsing, burlap bleaching, boiler blow down, and water conditioner back washing.
- Facility Description: The pretreatment facility consists of a sediment ditch with bar screens, two sediment pits, two pumps to convey the wastewater to the aerated storage lagoon, a magnetic flow meter with a chart recorder and totalizer, a surge control system and a low pressure cut off system. The wastewater is spray irrigated via a 4-center pivot system onto 45.15 acres planted in orchard grass and alfalfa.
- Location Map (Figure 3.3)

Figure 3.3 Location and layout of the James Thompson facility

3.1.5 Beaver Creek Regional Wastewater Treatment Facility (RIBs)

- OWTDS-RIB Permit Number: 359014-06
- Permittee: Artesian Wastewater Management, Inc.
- Operator: Artesian Wastewater Management, Inc.
- Facility Location: 26233 Maple Ln, Milton, DE 19968 (WWTF)
- Coordinates: 38.73242389051648, -75.28782229913165 (RIBS)
- Operational History: Constructed in 2016
- Discharge Volume: 143,403 GPD (2022 data)
- Discharge Description: Treated effluent is discharge into six (6) Rapid Infiltration Basins (RIBs) located at the front of the Beaver Creek subdivision.
- Facility Description: The WWTF consists of a Sequencing Batch Reactor (SBR) system located at the back of the Beaver Creek subdivision.
- Location map (Figure 3.4)

Figure 3.4 Location of the Beaver Creek Regional WWTF

3.1.6 Angola Beach & Estates Wastewater Treatment Facility (Spray)

- OWTDS-Spray Permit Number: 359000-05
- Permittee: Hometown Angola Beach, LLC
- Operator: Hometown Angola Beach, LLC
- Facility Location: 23063 Suburban Blvd, Lewes, DE 19958
- Coordinates: 38.66850104040601, -75.16586544293241
- Operational History: Constructed in 1986
- Discharge Volume: 90,524 GPD (2022 data)
- Discharge Description: The chlorinated effluent is spray irrigated on 14.17 acres utilizing 82 sprinkler heads, consisting of 11 zones planted in reed canary grass with forested perimeters and spray areas (Zones 1-5: Grasses; Zones 6-11 Woods).
- Facility Description: The WWTF consists of influent community pump stations with grinder pumps, one aerated lagoon with comminution, two storage/polishing lagoons, one sediment tank and wet well/lift station, one chlorine contact tank, and two 190 GPM irrigation pumps.
- Location map (Figure 3.5)

Figure 3.5 Location of the Angola Beach and Estates WWTF

3.1.7 Baywood Country Club Wastewater Treatment Facility (Spray)

- OWTDS-Spray Permit Number: 359012-04
- Permittee: Baywood, LLC
- Operator: Baywood, LLC
- Operational History: Constructed in 2009
- Facility Location: 24946 Dogleg Way, Long Neck, DE 19966
- Coordinates: 38.644680097230776, -75.18441557749327
- Discharge Volume: 49,107 GPD (2022 data)
- Discharge Description: Residential wastewater from the Baywood Golf Course Communities is collected, treated, and spray irrigated to a 54-acre golf course consisting of the driving range; holes 10, 13, 14, 15, 16, 17, 18; and area surrounding the wastewater lagoons.
- Facility Description: The WWTF consists of two wastewater treatment lagoons, filtration, and disinfection systems.
- Location map (Figure 3.6)

Figure 3.6 Location of the Baywood Country Club WWTF

3.1.8 Stonewater Creek Wastewater Treatment and Disposal Facility (RIBs)

- OWTDS-RIB Permit Number: 202221-02
- Permittee: Artesian Wastewater Management, Inc.
- Operator: Artesian Wastewater Management, Inc.
- Operational History: Since November 2005
- Facility Location: 24199 Indian Mission Road, Long Neck, DE 19966
- Coordinates: 38.654164, -75.214356
- Discharge Volume: 341,085 GPD (2021 data)
- Facility Description: The facility is authorized to receive and treat sanitary wastewater from Artesian's regional wastewater sewer system and Sussex County's sanitary sewer system. These sanitary sewer systems (in part) receive flow from developments identified in Conditional Use Approval No. 1629 granted by Sussex County. In addition, the Stonewater Creek facility is also able to deliver and receive influent/effluent flows to and from Sussex County's Inland Bays Wastewater Treatment and Disposal Facility.

  The influent flows to the facility shall not exceed a daily average of 225,000 gallons per day (gpd). The sanitary wastewater is treated by a dual Aqua-Aerobic sequencing batch reactor (SBR) wastewater treatment system and treated wastewater is discharged to six (6) rapid infiltration basins (RIBs) for final disposal.
- Location map (Figure 3.7)

Figure 3.7 Location of the Stonewater Creek WWTF

3.2 Sampling from Groundwater Discharge Facilities

Spray facilities- in addition to influent and effluent, groundwater samples from monitoring wells and soil samples from the sprayed fields will be collected. One surface water sample from a sprayed golf course (Baywood Green Country Club) will be sampled.

RIB facilities- in addition to influent and effluent, groundwater samples from monitoring wells will be collected. At selected facilities, soil within RIBs and surface water (upstream and downstream) will also be sampled.

Annual facility hydrological reports were reviewed, and groundwater flowing directions were considered when groundwater sampling locations were selected. In general, one upgradient well, one in-field well, and one downgradient well were selected for sampling.

Surface water samples from adjacent streams for two residential RIB facilities (Beaver Creek and Stonewater Creek) will be collected upstream and downstream of the RIBs to evaluate potential impacts from the groundwater discharges.

Sampling Frequency/Depth- Soils will be sampled once at 1 ft, 3 ft, and 6 ft depth levels from each selected location; while waters (influent, effluent, groundwater, and surface water) will be sampled quarterly for a year to observe potential seasonal variations.

Samples will be named in the following format.

- *Influent and Effluent:* Facility Code-IF or EF (*Quarter*), where Facility Code is defined as MS=Middletown Spray, MR=Middletown RIB, JT=James Thompson, SR=Sussex Regional Recharge Facility, BC=Beaver Creek, AB= Angola Beach, BW=Baywood Country Club, and SC=Stonewater Creek; IF= influent, EF=effluent; and *Quarter* is the number of quarterly sampling event. For example, **MR-IF1** will be the influent sample collected from the Middletown RIB Facility during the first (quarter) sampling event.
- *Groundwater:* Facility Code-GW+DNREC ID-(*Quarter*), where Facility Code = same as above; GW = groundwater; DNREC ID is the unique well permit ID issued by DNREC; and *Quarter* is the number of quarterly sampling event. For example, **MS-GW189210-2** will be the groundwater sample collected from the Middletown Spray facility from well whose DNREC ID is 189210 during the second (quarter) sampling event.

- *Soil:* Facility Code-SL(S*ite Number*)+a/b/c. Facility codes are the same as above. SL = soil; *Site Number* is decided when sampling location is determined and numbered (will be marked on the sampling location map for each facility); and "a/b/c" will be used to distinguish sampling depth: a=1 ft, b=3 ft and c=6ft. For example, **JT-SL1b** will be the soil sample collected from the James Thompson Spray facility at site location #1 and sample depth is 3 ft.

  If groundwater is encountered at 6 ft depth at a soil sampling site, make note of it and no sample will be collected at 6 ft depth (though samples at 1 ft and 3 ft will still be collected). If groundwater is encountered at 3 ft depth, consult with DNREC Project Officer before collecting any more samples (an alternative site may be selected).
- *Surface water*- Facility Code-SW(S*ite Number)-(Quarter*), where Facility Code = same as above; SW=surface water; *Site Number* is decided when sampling location is determined and numbered (will be marked on the sampling location map for each facility); and *Quarter* is the number of quarterly sampling event. For example, **BC-SW1-3** will be the surface water sample collected from the Beaver Creek facility at site #1 during the third quarterly sampling event

3.2.1 Town of Middletown Wastewater Treatment Facility (Spray)

There are 3 spray fields associated with the facility: Ford, Von Croy and Middletown Park. Twenty-five monitoring wells (24 active; 1 abandoned) were installed at the facility, 3 of which are selected for groundwater sampling in this study (DNREC ID:189204, 189206, and 189210). Figure 3.8 shows the locations of the spray fields and the monitoring wells at Ford Farm, as well as selected groundwater (wells) and soil sampling sites. Three sites are also selected for soil sampling (MS-SL1, MS-SL2, MS-SL3) as shown in Figure 3.8.

Influent and effluent will also be sampled at the facility.

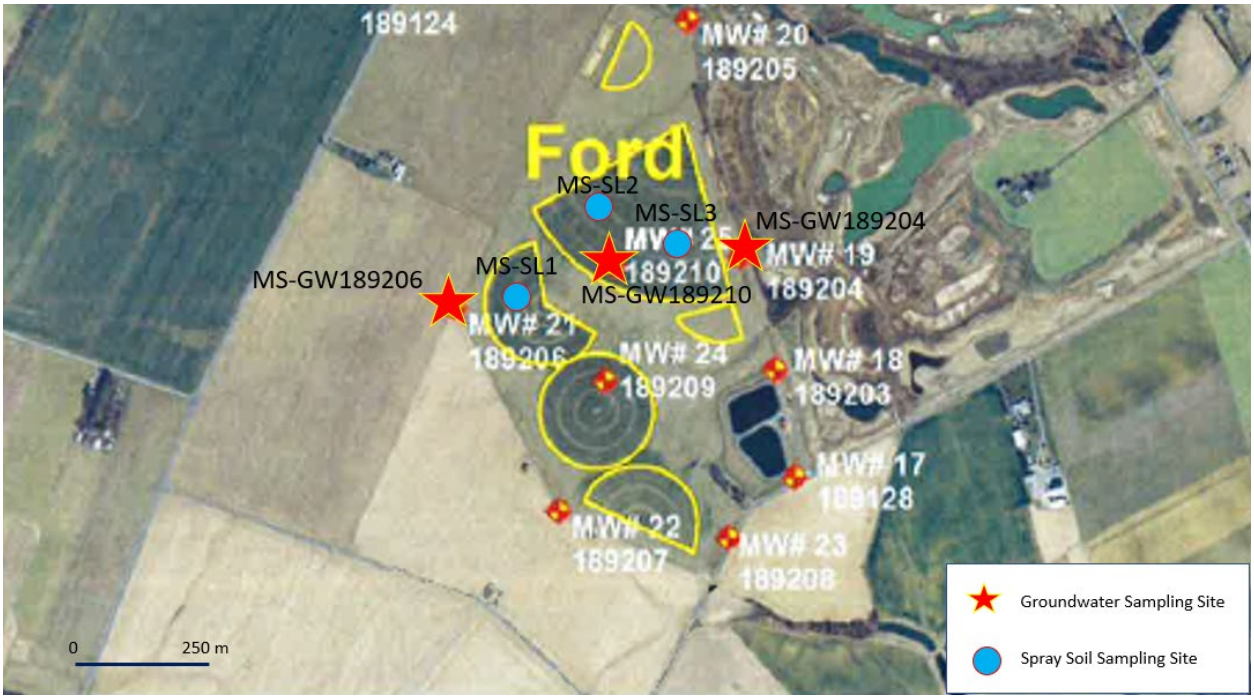

Figure 3.8 Proposed sampling sites at the Middletown spray fields (Ford Farm)

3.2.2 Town of Middletown Wastewater Treatment Facility (RIBs)

Twenty-one RIBs were installed at the Ford Farm. RIB #1 and RIB #2 were selected for this study. Eight monitoring wells (and two observation wells) were installed to monitor the operations of the 2 RIBs. Three monitoring wells (DNREC ID: 229533, 229535, and 229537) are selected for groundwater sampling (Figure 3.9).

Two sites (MR-SL1 and MR-SL2) are selected for soil sampling (see Figure 3.9 for site locations). Note that these two "soil" samples will be collected inside the RIB area, no vehicles can be driven into the RIB areas.

Influent and effluent for the Middletown RIBs are the same as those for spray, and thus no influent or effluent sample will be collected for the RIBs.

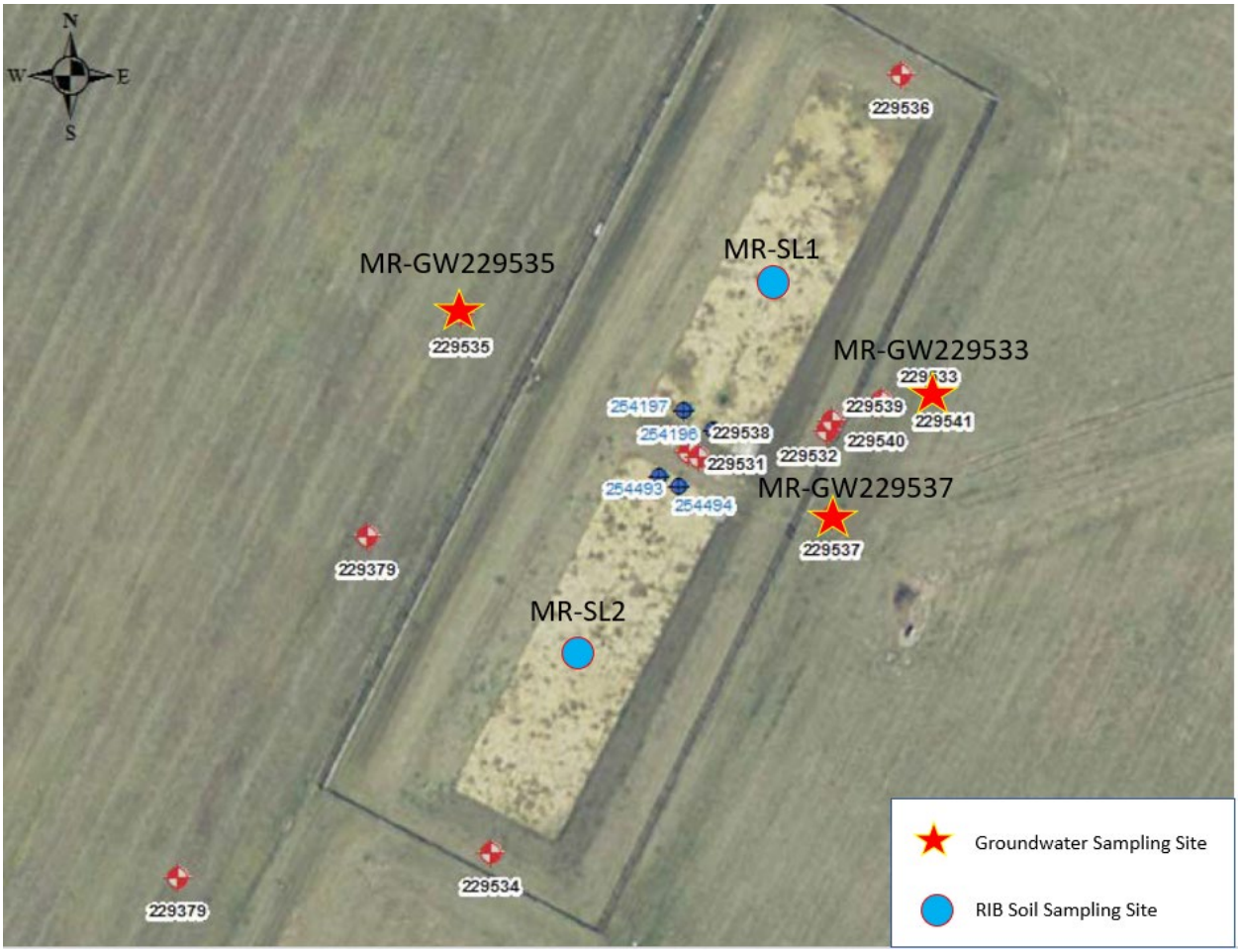

Figure 3.9 Proposed sampling sites at the Middletown RIB facility (Ford Farm)

3.2.3 Sussex Regional Recharge Facility (Spray)

As of January 2023, spray Field F, Field G and the on-site lagoon were operational at SRRF. Eighteen monitoring wells were installed to monitor the then operation.

Three monitoring wells (DNREC ID: 254882, 258635, and 258636) and two soil sampling sites (SR-SL1 and SR-SL2) are selected for this study (Figure 3.10). Note that SR-SL1 is placed on top of a groundwater sampling site (SR-GW258636), which means that the soil samples should be collected next to the well (ideally, within 10-15 feet).

Influent and effluent will also be sampled at the facility. While the SRRF effluent sample can be collected from the lagoon, the influent sample will have to be collected from the Allen Harim wastewater treatment plant, which is, currently, the sole source of wastewater for SRRF. Influent sample will be collected from the Allen Harim wastewater treatment plant at the effluent sampling location at the pump station.

Figure 3.10 SRRF sampling site locations

3.2.4 James Thompson and Company (Spray)

Thirteen monitoring wells were installed at the facility, 3 of which are selected for groundwater sampling in this study (DNREC ID:78710, 50018 and 10234). Two soil sampling sites (JT-SL1 and JT-SL2) are selected as well. Figure 3.11 shows locations of the sampling sites. Note that JT-SL1 is placed on top of a groundwater sampling site (JT-GW50018), which means that the soil samples should be collected next to the well (ideally, within 10-15 feet).

Influent and effluent from the facility will also be sampled.

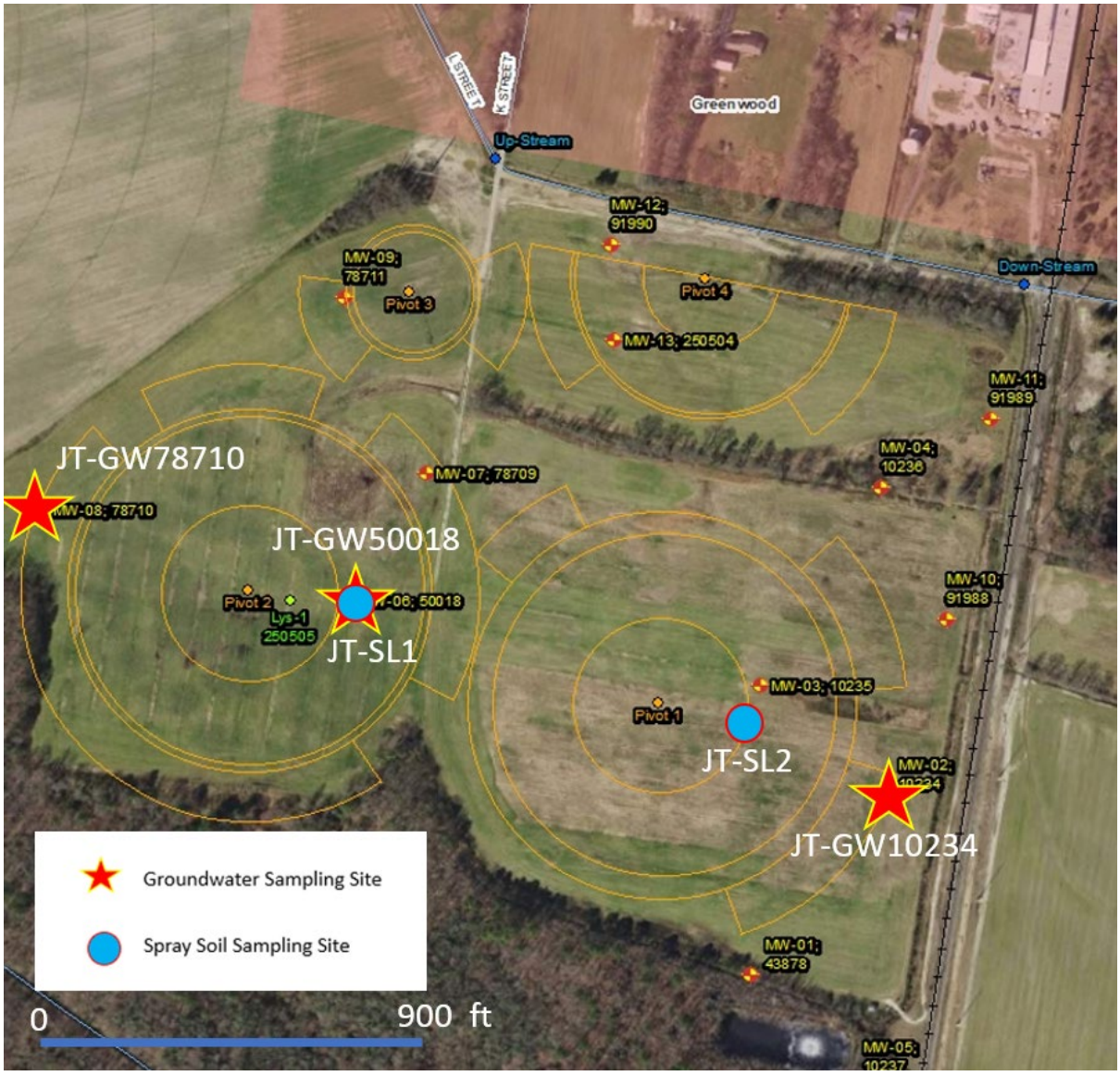

Figure 3.11 Spray fields and proposed sampling locations at the James Thompson Facility

3.2.5 Beaver Creek Regional Wastewater Treatment Facility (RIBs)

Two monitoring wells (DNREC ID: 211955 and 211956) are selected for groundwater sampling. To evaluate possible impact from the groundwater discharge facility, two surface water sampling sites are selected in the Beaverdam Creek immediately to the south of the facility: BC-SW1 (upstream; Road 5 crossing), and BC-SW2 (downstream, Carpenter Rd. crossing). Sample site locations are shown in Figure 3.12. Avoid driving inside the RIB area.

Influent and effluent will also be sampled at the facility.

3.2.6 Angola Beach & Estates Wastewater Treatment Facility (Spray)

Ten groundwater wells were installed at the facility to monitor the operations. Three wells (DNREC ID: 68812, 68813 and 93632), and two soil sampling sites (AB-SL1 and AB-SL2) for this study. Figure 3.13 shows the locations of these sites. Note that AB-SL2 is placed on top of a groundwater sampling site (AB-GW93632), which means that the soil samples should be collected next to the well (ideally, within 10-15 feet).

Influent and effluent samples will also be collected from the facility.

Figure 3.12 Sampling site locations of groundwater and surface water at the Beaver Creek RIB Facility

Figure 3.13 Groundwater and soil sampling sites at Angola Beach & Estates

3.2.7 Baywood Country Club Wastewater Treatment Facility (Spray)

Nine groundwater wells were installed to monitor the operations of the facility, three of which are selected for this study (DNREC ID: 216637, 179556 and 179557). Two soil sampling sites (BW-SL1 and BW-SL2) and one surface water (from the pond at the south-end; BW-SW1) sampling site are also selected for this study. Figure 3.14 shows all sampling site locations at the facility. Note that the facility is a golf club, no unauthorized vehicles should be driven on the turf area

during sampling. Note that BW-SL2 is placed on top of a groundwater sampling site (BW-GW179556), which means that the soil samples should be collected next to the well (ideally, within 10-15 feet).

Influent and effluent samples will also be collected from the on-site wastewater treatment plant.

Figure 3.14 Sampling site locations at the Baywood Green Country Club Facility

3.2.8 Stonewater Creek Wastewater Treatment Facility (RIBs)

Four monitoring wells were installed at Stonewater Creek, three of which are selected for groundwater sampling (DNREC ID: 209175, 209176, and 209177). To evaluate possible impact from the groundwater discharge facility, two surface water sampling sites are selected in the Phillips Branch to the north of the facility: SC-SW1 (upstream; Road 5 crossing), and SC-SW2 (downstream, Holly Lake Rd. crossing). The upstream surface water sampling site (SC-SW1) may be dry for most of the year (make a note of it, if so). Sample site locations are shown in Figure 3.15. Avoid driving inside the RIB area.

Influent and effluent will also be sampled at the facility.

Figure 3.15 Sampling site locations in the vicinity of Stonewater Creek

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

A Quality Assurance Project Plan (QAPP) will be developed for this study before the start of sampling. DNREC will select qualified contractors and laboratories to perform sample collection and analysis. These contractors will be required to submit Standard Operating Procedures (SOPs) and Quality Assurance and Quality Control Plans (QA/QC) to DNREC for approval prior to contracting. All samples (influent, effluent, groundwater, and soils) will be analyzed using EPA Method 1633.

5.0 PROJECT SCHEDULE

This project design and sampling plan will be finalized in April 2023. Sampling team(s) will be selected from State certified-listed contractors in May 2023 when communication with selected facilities should also be finalized. It is anticipated that field sampling would first occur in June 2023.

6.0 SUMMARY

DNREC- Division of Water intends to conduct a study on PFAS in wastewater influent-effluent, soils from spray fields and RIBs (discharge receiving media), and groundwater-surface water (post-discharge monitoring). Fifteen wastewater treatment and disposal facilities are selected for the study. A total of 56 influent, 56 effluent, 92 groundwater, 20 surface water, and 39 soil samples will be collected from wastewater treatment and disposal facilities in this study (Sections 2.0 and 3.0; Table 5.1). Actual numbers of samples will most likely be less than what Table 5.1 shows, due to possible dry creek beds at surface water sampling sites and encountering groundwater at deeper levels of soil sampling. In short, 224 water and 39 soil samples will be collected for the proposed study. Field sampling is expected to start in June 2023.

Facility Name	Influent and Effluent	Soil	Groundwater	Surface Water
City of Wilmington	8	NP	NP	NP
Kent County	8	NP	NP	NP
City of Rehoboth Beach	8	NP	NP	NP
M-O-T Regional Facility	8	NP	NP	NP
City of Seaford	8	NP	NP	NP
INV Performance Materials	8	NP	NP	NP
Perdue Foods	8	NP	NP	NP
Town of Middletown-Spray & RIB	8	15	24	NP
Sussex Regional Recharge Facility	8	6	12	NP
James Thompson	8	6	12	NP
Beaver Creek	8	NP	8	8
Angola Beach & Estate	8	6	12	NP
Baywood Country Club	8	6	12	4
Stonewater Creek	8	NP	12	8
Total	**112**	**39**	**92**	**20**

Table 5.1 Number of samples to be collected from each facility (per media; NP=Not Planned)

REFERENCE

DNREC, 2022: Project Design and Sampling Plan- PFAS in Biosolids: Characterization and Fate. *by* Division of Water, Department of Natural Resources and Environmental Control (DNREC); September 2022, pp. 14.

REVISION CHANGE LOG

Rev. 01

Facility change: Printpack was replaced by Purdue Foods

Rev. 02

Some sites were labeled wrong (corrected)

Rev. 03

Two Baywood GW wells were labeled with wrong DNREC IDs (corrected)