FINAL PROJECT REPORT

Fate and Transport of Per- and Polyfluorinated Alkyl Substances (PFAS) in Water, Sediments, and Oysters in Greenwich Near-Shore Waters of Long Island Sound

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BACKGROUND

Per-and polyfluorinated alkyl substances (PFAS) are man-made industrial and household substances that are emerging as pollutants of considerable concern. Since the 1960s, they have been used extensively in the United States and throughout the worldwide in a range of applications including non-stick cookware, water and stain repellents, food packaging, and firefighting foams. Perfluorooctansulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorohexanesulfonate (PFHxS) are typically the most common of the PFAS. These chemicals are stable and do not readily breakdown under natural conditions. They are especially problematic because of their high persistent, potential to be bioaccumulative, and capacity for long-range transport. Indeed, PFAS have been detected ubiquitously in various environmental matrices including sediment, biota, and water sources such rain, groundwater, rivers, lakes, and coastal seawaters. Groundwater, surface waters, and associated aquatic environments are especially at risk because PFAS are nonvolatile, moderately hydrophobic, and soluble in water, where they are likely to accumulate. This translated to increased exposure risks to humans as well as to wildlife and fisheries, including shell fish. PFAS are linked to adverse health effects, including immunotoxicity, developmental disorders, and cancer. The most extensively produced PFAS were mass-produced in the 1950s and voluntarily phased out of use throughout the United States in 2006. Nonetheless, they are still persistent in the environment.

Preliminary work in Connecticut and Long Island Sound (LIS) has examined PFAS in effluent from 12 waste water treatment plants (WWTPs), including Greenwich's WWTP. The effluent from WWTPs, through its suspended particulate was an effective transport medium for long-chained PFAS into receiving waters, including LIS where they may be assimilated by organisms and accumulated via predator-prey interactions into a number of aquatic or terrestrial species in local communities. This has implications for the recreational and commercial uses of LIS, including impacts to shellfish beds.

PROJECT OBJECTIVE

The project objective was to characterize spatial variation in a suite of PFAS in Greenwich embayments and quantify differences in concentrations in water, sediment, and biota.

STUDY AREA

We conducted a preliminary study concerning the fate and transport of 14 different PFAS chemicals (Appendix A) in oyster/shellfish beds in each of 4 harbors in Greenwich waters (i.e., **Byram Harbor** [BH], **Cos Cob Harbor** [CCH], **Greenwich Harbor** [GH], and **Greenwich Cove** [GC]), as well as in the newly designated **protected area** (PA) in Greenwich waters that contains an active oyster bed. The State of Connecticut has placed an emphasis on enhancing PFAS data collection, especially in areas that may impact ecological and human health (*Gov PFAS Task Force*). Specifically, CTDEEP has expressed concern regarding transport of PFAS from areas with known sources as well as concern about the identity of potential biotic receptors in LIS.

We established 3 sites in each of the oyster beds (Figure 1) and obtained a tripartite sample of associated water (mid depth), sediment (to 0.5 m), and oysters (composite samples of up to 10 individuals) from each. Similarly, we established 3 sites in the vicinity of the WWTP, where we obtained samples of water, sediment, and oysters from each site.

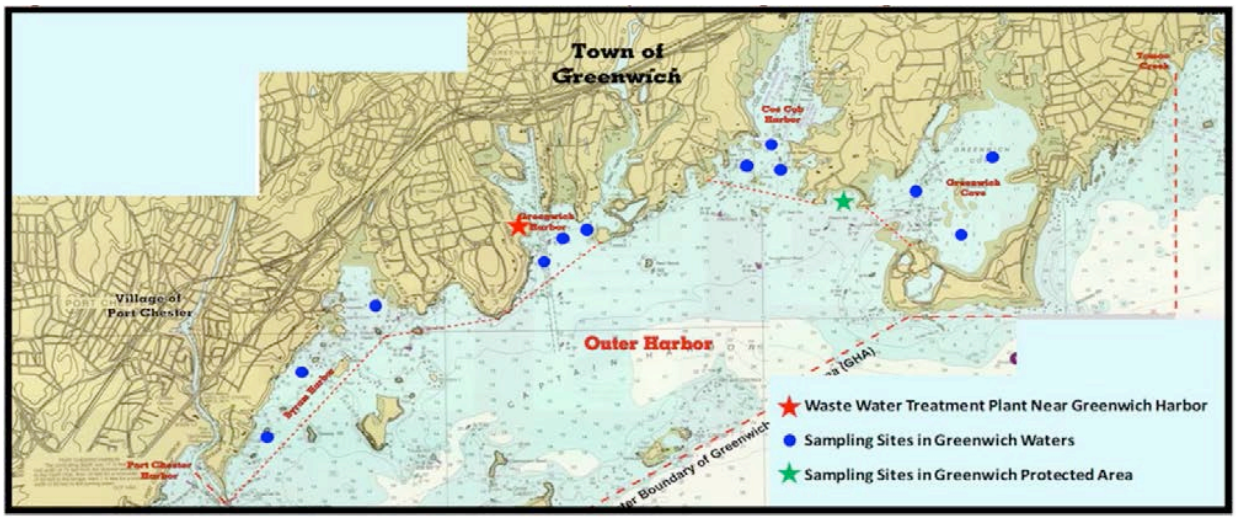


Figure 1. Sampling locations in the Greenwich Waters of Long Island Sound.

MATERIALS AND METHODS

Field Methods

Field work associated with PFAS is challenging because of contamination issues (i.e., among sample contamination, or contamination from field technician to sample). Consequently, field personnel required training and initial supervision before the collection of water, sediment, or oyster samples. Christopher Perkins, CESE Laboratory Director, conducted 2 training sessions and provided guidance to local field technicians. The detailed Field Collection and Sampling Procedures are included in Appendix B.

All samples were obtained at low tide (± 3 hours) and within a 14-day period. A field collection sheet was generated for each sampling site, which contained spaces to enter sampling site-specific information (e.g. latitude and longitude) as well as spaces for matrix-specific (sediment, water, and oyster) information. A duplicate sample of each matrix (water, sediment, or oyster) was collected from one of the three Greenwich Harbor sites. These duplicate samples were collected in the same general location as one of the three original samples and in the same manner as any other sample.

Sediment

Sediment samples were collected using a pre-cleaned box-corer lined with an acrylic liner. Between each sample and at the end of the sampling day, the core liner was cleaned and stored in a clean plastic bag. The representative sediment sample was obtained from the center of the box core. The top 2 inches of sediment was removed using a stainless steel spoon, using care to avoid taking sample material from sediment in contact with the liner, and placed into a pre-marked Ziploc plastic bag.

Water

Water samples were collected using a sub-surface grab sampler. The sampler was previously cleaned by CESE personnel, prior to delivery to Greenwich. Between each sample and at the end of the sampling day, a new or cleaned sample bottle was used. Each water sample was collected at mid-depth, with depth determined using a commercial depth finder. The sampler was lowered over the side of the vessel to the appropriate depth, upstream or upwind of the engine smoke-plume to avoid contamination. Once collected, the sample was poured into a pre-labeled HDPE sample bottle.

Oysters

Samples of bivalves were collected with assistance from a commercial shellfishery vessel equipped with a dredge. The shell-fishermen used their existing practices and procedures to harvest samples. Clean gloves were worn when handling the sampler to obtain shellfish. Shellfish samples were collected after both water and sediment samples were collected, thereby minimizing disturbance of sediment, which could otherwise have affected the results for those water and sediment samples. A minimum of 5 individual oysters per site was needed, with a target of 10 individual oysters collected per site. Hard shell clams were substituted for oysters at Greenwich Cove, because oyster availability was constraining. Shellfish samples were shucked and homogenized at CESE laboratories in a clean room to minimize potential contamination of the samples with PFAS.

Laboratory Methods

PFAS were measured in surface water using a modified version of USEPA Method 537. A 250 mL aliquot of each model solution was passed through an Oasis® HLB solid phase extraction (SPE) cartridge (500-mg, 6-mL, Waters, Inc., Milford, MA) and eluted with methanol. The extract was concentrated to dryness using a Genevac automated concentrator and adjusted to a 1-mL volume with 96:4% (vol:vol) methanol:water. Each sample was then transferred into vials for analysis using a Waters Acquity™ ultra performance liquid chromatograph (UPLC)® coupled with an Acquity™ TQD™ tandem mass spectrometer (Waters Co., Milford, MA). The detection and quantification of analytes, surrogates, and internal standard compounds were performed in negative ESI-MS/MS mode using the Waters, Inc. IntelliStart™ software and monitoring two transitions for each analyte.

A CESE method for the analysis of PFAS in biological tissue and sediment was used (Berger et al. 2019; Dorts et al. 2011). Homogenized samples were placed in a QuEChERS (i.e. dispersive extraction) vial and extracted using acetonitrile, followed by the addition of anhydrous magnesium sulfate and sodium acetate. The sample was then cleaned-up using SPE, and analyzed on the UPLC, using the same method as above.

Standard quality assurance protocols were be followed, which included duplicate, blank, and matrix spike samples.

Quantitative Analysis

Since all samples, regardless of matrix, location, or PFAS chemical, were below the analytical limit of detection, no quantitative analyses were warranted or possible.

RESULTS

We were unable to collect the target number of sediment and shellfish samples at each sampling location. The total number of samples collected and analyzed were 38 (Table 1). The reduced number of sediment samples was related to the hardness of the sediment and inability of the sediment box corer to “bite” into the substrate and collect sample material. The reduced number of oyster samples arose because some locations and sites did not contain shellfish. Where feasible, hard shelled clams were substituted for oysters, when the latter were not available but the former were available. Field duplicate samples (dup) were collected from Greenwich Harbor and an additional hard shelled clam sample was collected and analyzed from Greenwich Cove.

Table 1. Number of samples collected and analyzed or 14 different PFAS chemicals in Greenwich Waters of Long Island Sound.

SAMPLING LOCATIONS IN GREENWICH WATERS OF LONG ISLAND SOUND							
	Byram Harbor	Cos Cob Harbor	Greenwich Harbor	Greenwich Cove	Protected Area	Trip Blank	Total
Water samples per site	3	3	2+1 dup	3	1	1	13+1 dup
Sediment samples per site	3	2	2+1 dup	3	0	0	10+1 dup
Oyster samples per site	1	3	3+1 dup	4*	1	0	11+1 dup
Total number of samples	7	8	7+3 dups	10	2	1	38
Note: * a separate oyster and hard shelled clam sample was collected and anlayzed from the Greenwich Cove 2 site							

All samples that were collected and analyzed did not have any detectible concentrations of target compounds of PFAS. The individual data reports are included in Appendix C. The overall data quality for this project was well within acceptable limits. The Greenwich staff and residents that collected the field samples did an excellent job in avoiding PFAS contamination during the sampling process. The precautions to avoid sample contamination are extensive and are detailed in the field collection and sampling procedures (Appendix B). All quality control samples were within acceptable limits, including the deionized water trip blank which would have exhibited PFAS contamination if the field samples were stored and transported incorrectly.

CONCLUSIONS

In general, PFAS were not detected (ND) in samples collected and analyzed in conjunction with this project (ND is considered below the detection limit of analytical methods). Critically, the analytical methods used in the project are very sensitive and robust, in part because of the availability of state-of-the-art instrumentation at CESE. In general, the detection limits (DLs) were extremely low, with shellfish and sediment DLs ranging between 0.5 and 2.2 parts per billion, and water DLs ranging between 2 and 5 parts per trillion. One of the main potential sources of PFAS to Greenwich waters of LIS is the WWTP located within Greenwich Harbor, which would make this area most susceptible to PFAS contamination. Consequently, it is important to note even in the Greenwich Harbor area, no PFAS were detected in any of the matrices. Additionally, it is notable that the Greenwich Protected Area did not exhibit detectible concentrations of any of the targeted PFAS in any of three matrices, which is important for the long-term health, ecological integrity and functioning of that ecosystem.

ACKNOWLEDGMENTS

We would like to express our appreciation to the Town of Greenwich for its generous financial support of this project, and for its dedication to the goals of the UConn-Greenwich Partnership.

This research would not have been possible without the encouragement and support of the Greenwich Shellfish Commission, that has long supported the UConn-Greenwich partnership. In addition, we particularly acknowledge the Commission members, Sue Baker, Roger Bowgen, Joan Tracy Seguin, and Steve Kinner, for the critical provisioning of logistical support with respect to sampling, both in terms of availability of expert personnel who collected water, sediment and shellfish for analyses of PFAS, and allowing the use of its sampling vessel on Long Island Sound. Finally, this project also benefitted greatly by assistance from commercial shell fishermen – Stellamar Oysters – who assisted with sample collection and provided critical logistical support in terms of personnel and use of their vessel.

Literature Cited

Berger, U., A. Glynn, K.E. Holmstrom, M. Berglund, E.H. Ankarberg, and A. Tornkvist, *Fish consumption as a source of human exposure to perfluorinated alkyl substances in Sweden - Analysis of edible fish from Lake Vattern and the Baltic Sea.* Chemosphere, 2009. **76**(6): p. 799-804

Dorts, J., P. Kestemont, P.A. Marchand, W. D'Hollander, M.L. Thezenas, M. Raes, and F. Silvestre, *Ecotoxicoproteomics in gills of the sentinel fish species, Cottus gobio, exposed to perfluorooctane sulfonate (PFOS).* Aquat Toxicol, 2011. **103**(1-2): p. 1-8

Appendix A

List of PFAS compounds analyzed as part of this study.

Compound	Acronym
N-ethyl perfluoroocatane sulfonamidoacetic acid	NEtFOSAA
N-methyl perfluorooctane sulfonamidoacetic acid	NMeFOSAA
Perfluorobutanesulfonic acid	PFBS
Perfluorodecanoic acid	PFDA
Perfluorododecanoic acid	PFDoA
Perfluoroheptanoic acid	PFHpA
Perfluorohexanoic acid	PFHxA
Perfluorohexanesulfonic acid	PFHxS
Perfluorononanoic acid	PFNA
Perfluorooctanoic acid	PFOA
Perfluorooctanesulfonic acid	PFOS
Perfluorotetradecanoic acid	PFTA
Perfluorotridecanoic acid	PFTrDA
Perfluoroundecanoic acid	PFUnA

APPENDIX B

Field Sampling and Collection Procedures

For the Project

Fate and Transport of Per- and Polyfluorinated Alkyl Substances (PFAS)

in

Water, Sediments, and Oysters in Greenwich Near-Shore Waters of Long Island Sound

By

Christopher Perkins

The Center for Environmental Sciences and Engineering

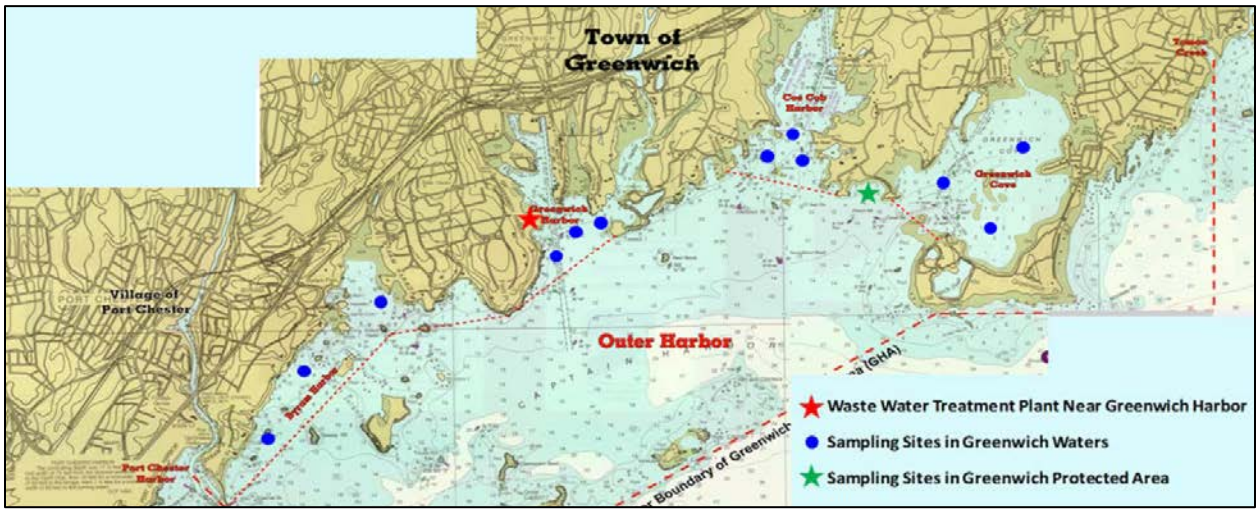
University of Connecticut

General Sampling Guidance

Sampling for PFAS can be challenging due to the prevalence of these compounds in a wide variety of consumer products, especially “personal care products”. Thus, we emphasize the following sampling precautions and guidelines:

- Clothing worn in the field should **not** contain Gore-Tex or Tyvek;
- Personnel should **not** use fabric softener on clothing to be worn in field;
- During the morning of sampling, cosmetics, moisturizers, hand cream, or other related products should **not** be used by field personnel;
- All containers should be made of High Density Polyethylene (HDPE) or polypropylene; and
- Ballpoint pens must be used rather than permanent pens when recording data or marking containers.

Study Locations



- There are 4 main study locations for this project Byram Harbor [BH], Cos Cob Harbor [CCH], Greenwich Harbor [GH], and Greenwich Cove [GC]), as well as one in the newly designated protected area (PA) in Greenwich waters. Three sites will be sampled from each of the 4 main locations, and 1 site will be sampled from the PA. The location of sites (shown in blue in the figure) are approximate and some flexibility is allowed in their selection for sampling.
- One water, sediment, and oyster sample is collected from each site.
- All samples must be obtained at low tide (±3 hours) and within a 14 day period.
- A field collection sheet will be generated for each sampling site. Each field collection sheet contains spaces to enter sampling site-specific information (e.g. latitude and longitude) as well as spaces for matrix-specific information (i.e., sediment, water, and oyster).
- The convention for characterizing sample labels is: location – site number – matrix
    - For example: BH-1-Sediment; or GH-3-Water; or PA-1-Oyster

- A duplicate sample of each of the target matrices (water, sediment, oyster) will be collected from one of the three Greenwich Harbor sites. This duplicate sample will be collected in the same general location of one of the three original samples, and will be collected in the same manner as any other sample. This means that in Greenwich Harbor, a total of 4 samples will be collected from three sites. The duplicate will be labeled in the format as above, where the addition of the letter "D" denotes the duplicate sample for each matrix (e.g. GH-3-Water-D).
- Prior to the start of the first sampling trip, personnel should completely fill one of the HDPE water sample bottles with the ultra-pure water (provided previously by CESE). Tighten the cap and place it in a Ziplock bag. Place the secured sample in the cooler for the duration of the sampling trip. This quality control sample is called a "trip blank", and is to be handled and stored in the same manner as the regular samples. If any contamination occurs during the sample storage and transport process, it will show in this sample. The duplicate will be labeled in a format similar to the format above, where the addition of the letter "TB" denotes the trip blank (e.g. TB-Water).

Sediment Sampling

Sediment samples will be collected using a box-corer lined with acrylic. The corer has been previously cleaned by CESE personnel, prior to delivery to Greenwich. Between each sample and at the end of the sampling day, the core liner **must** be cleaned, according to the procedures described below, and stored in a clean plastic bag at the end of the sampling day. Make sure to wear the gloves provided when handling the sediment sampler. For each sampling site, a separate field collection sheet (Appendix) must be completed.

- Record the appropriate information on the field collection sheet.
- Remove the corer from the case and the liner from the plastic bag.
- Place the corer on the clean HDPE cutting board, the lower jaws opened so that the corer lays flat, and the liner inserted into the corer.

- Secure the cotter pin into the base of the corer locking the liner in place
- Secure the screen and rubber flap to the top of the corer to prevent water from affecting the sediment surface when retrieving the sample.
- Secure the corer in the open/sampling position by inserting the metal pin (which is attached to the corer with a chain) through the small opening at the top of the corer.
- Lift the corer from the cutting board, using the carabiner, and place it on the side of the boat.
- Drop the corer over the side of the vessel, allowing it to freely descend and dig into the sediment. The metal pin securing the corer open, will release allowing the corer jaws to close.

- The attached rope is pulled, closing the bottom of the corer, it is pulled up to the surface, brought into the boat, and lowered onto a clean polyethylene cutting board.
- Remove the rubber screen, exposing the top of the corer.
- The sample is obtained from the center of the sediment core. Remove the top 2 inches of sediment using a stainless steel spoon, exercising care to avoid taking sample from sediment in contact with the liner, and place it into a pre-marked Ziploc plastic bag.
- Seal the cup, place it in a second individual Ziploc plastic bag, and then place it into a cooler.
- The sample is held at 4 ^{o}C on ice or refrigeration until shipped or delivered to the laboratory at CESE.
- Removed the acrylic liner between samples, rinse with ambient seawater, replace it in the dredge, and secure it as above.
- Note that if any shellfish were obtained during this grab, then these can be used for the bivalve collection (see below).

Water Sampling

Water samples will be collected using a sub-surface grab sampler. The sampler was previously cleaned by CESE personnel, prior to delivery to Greenwich. Between each sample and at the end of the sampling day, a new or cleaned sample bottle must be used. If a bottle needs to be cleaned, the procedures described below must be used, and the sampler must be stored in a clean plastic bag at the end of the sampling day. Make sure to wear the gloves provided when handling the water sampler. For each sampling site, a separate field collection sheet (Appendix) must be completed.

Each water sample must be collected at mid-depth. Depth can be determined using commercially available depth finders, or using a weighted, measured, line. The length of the sampling boom has been marked every 6 inches with label tape to guide sample collection depth. Turn off the engine of the boat for at least 5 minutes prior to sampling.

- Remove the sampler from the plastic bag.
- Make sure a clean glass sample bottle is screwed into the HDPE housing of the sampler.
- Lower the sampler over the side of the vessle, to the appropraite depth, and do so upstream/wind of the engine smoke plume to avoid contamination.
- Pull the sampling cable located at the proximal end of the sampler, and hold this for at least 30 seconds, ensuring that the sample bottle has filled.
- Release the sample cable and pull the sampler out of the water.
- Unscrew the glass ample bottle from the sampler.
- Pour the sample into a pre-labeled HDPE sample bottle.

- Secure the cap on the HDPE bottle, place it in an individual Ziploc plastic bag, and then place it into a cooler.
- The sample must be held at 4 ^{o}C on ice or refrigeration until shipped or delivered to the laboratory at CESE.
- Place a new or cleaned glass bottle into the HDPE housing of the sampler.
- Store the sampler in a plastic bag between collection events.

If clean or new glass sampling bottles are not available, the bottles must be cleaned between the collection of each sample. If this is required, rinse the sample bottle with ambient seawater and discard, add 50 mL (approximately) of 3% hydrochloric acid to the sample bottle. Wrap clean aluminum foil around the neck of the sample bottle, closing off the opening, place the bottle cap over the aluminum foil, and tighten the cap. Shake the bottle for 20 seconds, remove the cap, and pour the dilute acid into the waste container (provided). Add approximately 50 mL of Deionized Water (provided) to the sample bottle. Wrap clean aluminum foil around the neck of the sample bottle, closing off the opening, place the bottle cap over the aluminum foil, and tighten the cap. Shake the bottle for 20 seconds, remove the cap and pour the water rinse into the waste container (provided). Repeat this deionized water rinse two more times. Store the bottle in a clean plastic bag between sampling trips.

Oyster Sample Collection

Oyster samples can be collected using multiple techniques. These include, using a box-corer lined with an acrylic liner, or via assistance from a commercial shellfishery vessel equipped with a dredge or other similar equipment. If a box-corer is used, then the sediment collection method will be followed (above). If a commercial vessel is used, then the shell-fishermen will use their existing practice to harvest samples. Make sure to wear the gloves provided when handling the sediment sampler. For each sampling site, a separate field collection sheet (Appendix) must be completed.For the oyster samples, there is one additional element that must be added to the sample labels, the individual sample number/total number of samples collected for that site (example: GH-1-Oyster 3/10). If there are species substitution then the labeling should reflect this accordingly (GH-1-Clam 4/10).

- If commercial harvest methods are used, shellfish samples must be collected ***AFTER*** both water and sediment samples have been collected. This will minimize the disturbance of sediment, which will affect the results for those two samples.
- A minimum of 5 individual oysters per site is required, with a target of 10 individuals collected per site. If 10 oysters are not able to be collected from a particular site, then alternative species (e.g. hardshell clams) can be substituted. Any substitutions must be noted on the field collection sheet.
- Rinse each oyster with ambient seawater to remove sediment adhering to the surface.

- Place each oyster into an individual pre-marked Ziploc plastic bag and place it into a cooler.
- The samples are held at 4^{o}C on ice or refrigeration until shipped or delivered to the laboratory.

Greenwich PFAS Project

Water, Sediments, and Oysters Field Collection Sheet

Collection Date:_____ Collection Time:_____

Collector(s):_____

Weather Conditions:_____

Sample Location Name: _____ Site Number: _____

Latitude: _____Longitude: _____

Sample Site Description: _____

Water Collection Information:

Water Depth: _____ Approximate Sample Depth:_____

Rinsed after Collection from each Site: Y / N (circle one)

Replicate Sample Collected?: Y / N (circle one) Replicate Sample ID:_____

Sediment Collection Information:

Sediment Sample Depth: _____

Rinsed after Collection from each Location: Y / N (circle one)

Replicate Sample Collected?: Y / N (circle one) Replicate Sample ID:_____

Oyster Collection Information:

Water Depth: _____

Collection Method: Hand / Corer / Dredge/ Other:_____

Number of Oysters Collected: _____ Number of Non-Oysters Collected: _____

If Non-Oysters are Collected Note the Alternative Species: _____

Appendix C

Individual PFAS Data Reports
For
Water, Sediment, and Shellfish

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Analysts: A. Provatas

UCONN-CESE
Order # 200295
Matrix: Water
Contact: Perkins/Willig
Report Date: 10/26/2020
Reported by: C. Perkins

Instrument				UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS
Units	WET WEIGHT			ng/mL	ng/mL	ng/mL	ng/mL	ng/mL	ng/mL	ng/mL	ng/mL	ng/mL	ng/mL	ng/mL	ng/mL	ng/mL	ng/mL
Prep date				10/21/20	10/21/20	10/21/20	10/21/20	10/21/20	10/21/20	10/21/20	10/21/20	10/21/20	10/21/20	10/21/20	10/21/20	10/21/20	10/21/20
Analysis date				10/26/20	10/26/20	10/26/20	10/26/20	10/26/20	10/26/20	10/26/20	10/26/20	10/26/20	10/26/20	10/26/20	10/26/20	10/26/20	10/26/20
CESE ID	Field ID	Collected	Recieved	Perfluorobutanesulfonic acid PFBS	Perfluorohexanoic acid PFHxA	Perfluoroheptanoic acid PFHpA	Perfluorohexanesulfonic acid PFHxS	Perfluorooctanoic acid PFOA	Perfluorooctanesulfonic acid PFOS	Perfluorononanoic acid PFNA	NMeFOSAA	Perfluorodecanoic acid PFDA	NEtFOSAA	Perfluoroundecanoic acid PFUnA	Perfluorotetradecanoic acid PFTA	Perfluorododecanoic acid PFDoA	Perfluorotridecanoic acid PFTrDA
200295-001	GC1		10/05/20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
200295-002	GC2		10/05/20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
200295-003	GC3		10/05/20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
200295-004	PA		10/05/20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
200295-005	CC1		10/05/20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
200295-006	CC2		10/05/20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
200295-007	CC3		10/05/20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
200295-008	GH1		10/05/20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
200295-010	GH3		10/05/20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
200295-011	BH1		10/05/20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
200295-012	BH2		10/05/20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
200295-013	BH3		10/05/20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
200295-036	TB		10/05/20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
200295-038	GH1 dup		10/05/20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
			Reporting Limit	0.0021	0.0026	0.0018	0.0032	0.0018	0.0023	0.0036	0.0024	0.0046	0.0028	0.0030	0.0016	0.0022	0.0046

Notes:

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Analysts: A. Provatas

UCONN-CESE
Order # 200295
Matrix: Sediment
Contact: Perkins/Willig
Report Date: 1/22/21
Reported by: C. Perkins

Instrument				UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS
Units	**WET WEIGHT**			ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
Prep date				1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21
Analysis date				1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21	1/14/21
CESE ID	**Field ID**	**Collected**	**Recieved**	**Perfluorobutanesulfonic acid PFBS**	**Perfluorohexanoic acid PFHxA**	**Perfluoroheptanoic acid PFHpA**	**Perfluorohexanesulfonic acid PFHxS**	**Perfluorooctanoic acid PFOA**	**Perfluorooctanesulfonic acid PFOS**	**Perfluorononanoic acid PFNA**	**NMeFOSAA**	**Perfluorodecanoic acid PFDA**	**NEtFOSAA**	**Perfluoroundecanoic acid PFUnA**	**Perfluorotetradecanoic acid PFTA**	**Perfluorododecanoic acid PFDoA**	**Perfluorotridecanoic acid PFTrDA**
200295-014	GC1	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-015	GC2	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-016	GC3	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-017	CC2	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-018	CC3	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-019	GH2	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-020	GH3	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-021	GH2 dup	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-022	BH1	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-023	BH2	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-024	BH3	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
			Reporting Limit	0.4	1.2	0.9	0.5	1.0	0.6	2.2	18.8	1.1	26.8	2.0	1.2	2.1	4.2

Notes:

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Analysts: A. Provatas

UCONN-CESE
Order # 200295
Matrix: Shellfish
Contact: Perkins/Willig
Report Date: 2/2/201
Reported by: C. Perkins

Instrument				UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS	UPLC/MSMS
Units	**WET WEIGHT**			ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
Prep date				1/21/21	1/21/21	1/21/21	1/21/21	1/21/21	1/21/21	1/21/21	1/21/21	1/21/21	1/21/21	1/21/21	1/21/21	1/21/21	1/21/21
Analysis date				1/24/21	1/24/21	1/24/21	1/24/21	1/24/21	1/24/21	1/24/21	1/24/21	1/24/21	1/24/21	1/24/21	1/24/21	1/24/21	1/24/21
CESE ID	**Field ID**	**Collected**	**Recieved**	**Perfluorobutanesulfonic acid PFBS**	**Perfluorohexanoic acid PFHxA**	**Perfluoroheptanoic acid PFHpA**	**Perfluorohexanesulfonic acid PFHxS**	**Perfluorooctanoic acid PFOA**	**Perfluorooctanesulfonic acid PFOS**	**Perfluorononanoic acid PFNA**	**NMeFOSAA**	**Perfluorodecanoic acid PFDA**	**NEtFOSAA**	**Perfluoroundecanoic acid PFUnA**	**Perfluorotetradecanoic acid PFTA**	**Perfluorododecanoic acid PFDoA**	**Perfluorotridecanoic acid PFTrDA**
200295-025	GC1	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-026 clam	GC2	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-026 oyster	GC2	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-027	GC3	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-028	CC1	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-029	CC2	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-030	CC3	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-031	GH1	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-032	GH1 dup	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-033	GH2	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-034	GH3	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-035	PA	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
200295-037	BH1	n/a	10/05/20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
			Reporting Limit	0.4	1.2	0.9	0.5	1.0	0.6	2.2	18.8	1.1	26.8	2.0	1.2	2.1	4.2

Notes: