



Agenda Report

2725 Judge Fran Jamieson
Way
Viera, FL 32940

Public Hearing

H.5.

2/8/2022

Subject:

Extension of Temporary Moratorium on New Applications of Biosolids to Lands within Brevard County - Public Hearing.

Fiscal Impact:

FY 21/22: Advertising Costs

Dept/Office:

Natural Resources Management

Requested Action:

It is requested that the Board of County Commissioners conduct a public hearing on adopting an extension of the 180-day moratorium on any new applications of biosolids to lands within Brevard County.

Summary Explanation and Background:

The moratorium was initially in response to a blue-green cyanobacteria, *Dolichospermum circinale*, bloom in Lake Washington in July 2019, which generated questions about the safety of a primary drinking water supply for Brevard County. Toxin levels measured during the 2019 bloom were low and did not indicate human health concerns. Additional blooms producing toxic microcystins, still below thresholds for human health concerns, were documented in September 2020, March 2021, December 2021 and January 2022.

Based on available data at the time of the initial moratorium, largest likely contributors to harmful blooms were nutrients from the land application of biosolids and/or commercial fertilizer on agricultural lands upstream and west of the lake, state water management projects upstream of the lake, or commercial/industrial and residential development and septic systems east of the lake. Additional studies by multiple agencies after the 2019 bloom provide increased evidence that the land application of biosolids is the most significant source of increasing phosphorus concentrations and associated risk of toxic blooms in Lake Washington.

State biosolids rule revisions adopted in 2020 are expected to reduce phosphorus pollution but not prevent it. Funding was provided to the St. Johns River Water Management District for biosolids research on the continuing impacts under the new rule and to inform future rule revisions and potential mitigation measures. This research is underway with completion expected by mid-2025.

History:

On October 8, 2019, in regular session, the Brevard County Commission approved Ordinance 19-20, a 180-day moratorium on any new permits that would expand the application of biosolids to lands in Brevard County. The moratorium was in response to a blue-green cyanobacteria, *Dolichospermum circinale*, bloom in Lake

Washington in the summer of 2019, which generated questions about the safety of a primary drinking water supply for Brevard County. Toxin levels measured during the 2019 bloom were low and did not indicate human health concerns, but to ensure public safety, the Board directed staff to sample potential causes or contributing factors of lake pollution and report back to the Board in six months.

County staff collaborated with the University of Florida, United States Department of Agriculture's Natural Resources Conservation Service, Brevard Soil and Water Conservation District, Florida Department of Environmental Protection, and St. Johns River Water Management District to develop a sampling plan. A multi-agency team collaborated to collect 50 soil samples from the ranch while Applied Ecology, Inc., with supervision from county and University of Florida staff, collected 11 water samples, and 3 grass tissue samples. Samples were tested for multiple forms of nitrogen and phosphorus, and other contaminants of emerging concern at Deer Park Ranch, upstream of and within Lake Washington, and in residential drainage canals entering Lake Washington from the east.

The soil and water samples both indicated that elevated levels of phosphorus from state-permitted land application of biosolids to cattle pastures leave Deer Park Ranch and enter the St. Johns River during periods of heavy rain. Soil data indicated that a long history of land applying biosolids on the ranch has exceeded the capacity of most pasture soils to hold all the phosphorus. The resultant release of excess phosphorus contributes to altered nitrogen to phosphorus concentration ratios in local surface waters and associated increased risk of harmful algal blooms in Lake Washington, an important source of local drinking water.

No elevated levels of contaminants of concern for human health were found leaving Deer Park Ranch. While a few pharmaceuticals were found in plant tissue samples on the ranch, these were not found in water leaving the site. Metals leaving the site were low concentrations, below drinking water threshold values, assuming typical hardness values for local surface waters. The Water Sampling Report and Soil Sampling Results are attached.

The Board of County Commissioners voted in favor of 180-day extensions of the temporary biosolids moratorium in April and October of 2020 and again in March and August of 2021, as Ordinances 2020-05, 2020-18, 2021-07, and 2021-20 respectively.

Biosolids legislation in Senator Mayfield's Clean Waterways Act (Senate Bill 712) was approved by the Legislature on March 12, 2020. This legislation directed the Department of Environmental Protection (FDEP) to revise its rules to reduce the impacts of biosolids on water quality and allows for the extension of county biosolids moratoria adopted prior to November 1, 2019. On June 21, 2021, Governor DeSantis signed House Bill 1309 allowing the FDEP to move forward with rule adoption without review by the Environmental Regulation Commission.

Clerk to the Board Instructions:

If adopted, please return a certified copy of the ordinance to Natural Resources.

Deborah Thomas

From: County Ordinances <CountyOrdinances@dos.myflorida.com>
Sent: Thursday, February 10, 2022 3:58 PM
To: Deborah Thomas; County Ordinances
Cc: Kimberly Powell
Subject: RE: BRE20220208_ORDINANCE2022_04
Attachments: Brevard20220210_Ordinance2022_04_Ack.pdf

Linda Bryant, Accountant I
Florida Department of State
Administrative Code and Register
500 South Bronough Street
Tallahassee, Florida 32399-0250

From: Deborah Thomas <deborah.thomas@brevardclerk.us>
Sent: Thursday, February 10, 2022 12:43 PM
To: County Ordinances <CountyOrdinances@dos.myflorida.com>
Cc: Kimberly Powell <Kimberly.Powell@brevardclerk.us>
Subject: BRE20220208_ORDINANCE2022_04

EMAIL RECEIVED FROM EXTERNAL SOURCE

The attachments/links in this message have been scanned by Proofpoint.

Good afternoon:

Please note the Ordinance No. 2022-04 to be filed with the State.

Thank you.

Deborah Thomas
Clerk to the Board
400 South Street
Titusville, FL 32780
(321)637-2001

This email was scanned by Bitdefender

Under Florida law, all correspondence sent to the Clerk's Office, which is not exempt or confidential pursuant to Chapter 119 of the Florida Statutes, is public record. If you do not want the public record contents of your e-mail address to be provided to the public in response to a public records request, please do not send electronic mail to this entity. Instead, contact this office by phone or in writing.

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FLORIDA DEPARTMENT of STATE

RON DESANTIS
Governor

LAUREL M. LEE
Secretary of State

February 10, 2022

Honorable Rachel M. Sadoff
Clerk
Board of County Commissioners
Brevard County
Post Office Box 999
Titusville, Florida 32781-0999

Attention: Deborah Thomas

Dear Ms. Sadoff:

Pursuant to the provisions of Section 125.66, Florida Statutes, this will acknowledge receipt of your electronic copy of Brevard County Ordinance No. 2022-04, which was filed in this office on February 10, 2022.

Sincerely,

Anya Owens
Program Administrator

AO/lb



February 9, 2022

M E M O R A N D U M

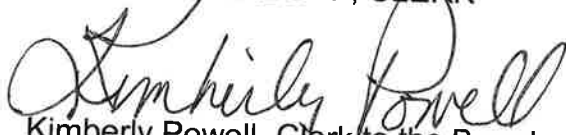
TO: Virginia Barker, Natural Resources Management Director Attn: Amanda Elmore
RE: Item H.5., Extension of Temporary Moratorium on New Applications of Biosolids to Lands within Brevard County – Public Hearing

The Board of County Commissioners, in regular session on February 8, 2022, conducted the public hearing and executed and adopted Ordinance No. 22-04, extending the 180-day moratorium on new applications of biosolids to lands within Brevard County. Enclosed is a certified copy of the Ordinance.

Your continued cooperation is always appreciated.

Sincerely,

BOARD OF COUNTY COMMISSIONERS
RACHEL M. SADOFF, CLERK


Kimberly Powell, Clerk to the Board

Encl. (1)

ORDINANCE NO. 2022- 04

AN ORDINANCE OF THE BOARD OF COUNTY COMMISSIONERS OF BREVARD COUNTY, FLORIDA AUTHORIZING AN EXTENSION OF TEMPORARY COUNTY-WIDE MORATORIUM FOR 180 DAYS FROM THE EFFECTIVE DATE; PROHIBITING THE LAND APPLICATION OF CLASS B BIOSOLIDS EXCEPT EXISTING PERMITTED ACTIVITIES; PROVIDING FOR EXHAUSTION OF ADMINISTRATIVE REMEDIES; AND PROVIDING FOR SEVERABILITY, REPEAL OF CONFLICTING PROVISIONS, RESOLUTION OF CONFLICTING PROVISIONS; AREA ENCOMPASSED AND AN EFFECTIVE DATE.

WHEREAS, as provided in Article VIII, Section 1 of the Florida Constitution and Chapter 125, Florida Statutes, counties have broad home rule powers to enact ordinances, not inconsistent with general or special law, for the purpose of protecting the public health, safety and welfare of the residents of the county; and

WHEREAS, Class B biosolids are solid, semi-solid, or liquid materials resulting from the treatment of domestic waste from sewage treatment facilities that contain nutrients such as phosphorus and nitrogen; and

WHEREAS, Elevated levels of phosphorus and nitrogen have been a point of concern for estuaries and watersheds across the state, as correlative connections have been observed between elevated levels of phosphorus and nitrogen, algal blooms, and the growth of noxious vegetation; and

WHEREAS, the land application of biosolids has been identified as a potential explanation for toxic algae blooms that occurred in Blue Cypress Lake in 2018 and Lake Washington in 2019¹; and

WHEREAS, Lake Washington provides water supply for the City of Melbourne's potable water utility that supplies drinking water to approximately 170,000 residents in

¹ St. Johns Water Management District Update to the Biosolids Technical Advisory Committee, January 23, 2018. Patterns in Surface Water Phosphorus Concentrations and Biosolids Utilization in the Upper St. Johns River: January 2019 Update.

OFFICIALLY FILED WITH THE SECRETARY OF STATE ON FEBRUARY 10, 2022

Melbourne, West Melbourne, Palm Shores, Satellite Beach, Indian Harbour Beach, Indialantic, Melbourne Beach and portions of unincorporated Brevard County; and

WHEREAS, preliminary analysis of available ambient water quality data by St. Johns River Water Management District indicates a potential, but not conclusive, relationship between the cumulative amount of phosphorus applied to land in biosolids and increasing phosphorus concentrations in downstream waters¹; and

WHEREAS, preliminary analysis by St Johns River Water Management District of available ambient water quality data for watersheds with lower levels of biosolids application do not indicate similar trends of increasing phosphate concentrations²; and

WHEREAS, watersheds receiving biosolids and experiencing increasing phosphorus concentrations in downstream waters are not showing increased turbidity or total suspended solids, reducing the likelihood that erosion is the source of increasing phosphorus concentrations¹; and

WHEREAS, watersheds receiving biosolids and experiencing increasing phosphorus concentrations in downstream waters are not showing increased total organic carbon, reducing the likelihood that natural export processes are the source of increasing phosphorus concentrations¹; and

WHEREAS, watersheds receiving biosolids and experiencing increasing phosphorus concentrations in downstream waters are not showing significant changes in land use, reducing the likelihood that development is the source of increasing phosphorus concentrations²; and

WHEREAS, the most prevalent land use within the watersheds at issue is agriculture and there are few other known sources of phosphorus loading large enough

² St. Johns Water Management District Update to the Biosolids Technical Advisory Committee, November 28, 2018. Patterns in Surface Water Phosphorus Concentrations and Biosolids Utilization in the Upper St. Johns River.

to potentially explain the increasing phosphate level trends in the Upper Basin of the St Johns River, including Brevard² and;

WHEREAS, other possible sources of increasing phosphorus in Lake Washington include septic systems on the east side of Lake Washington; water coming from flooded water management areas south of Highway 192 in Brevard and Indian River Counties that used to be crop land; and phosphorus applied to homeowner yards; and

WHEREAS, biosolids from Brevard County-operated wastewater treatment plants are safely disposed of in the lined County landfill while biosolids from multiple cities in Brevard are land applied; and

WHEREAS, biosolids being land applied in Brevard County and neighboring counties are primarily from South Florida where landfill costs are higher than the cost to truck biosolids to the Upper Basin of the St Johns River, with only 11% of biosolids applied within the Upper Basin produced by utilities within the Upper Basin²; and

WHEREAS, biosolids application in the Upper Basin tripled in 2013, continuing thereafter, in response to when rule revisions to protect the Everglades became fully effective²; and

WHEREAS, the land application of biosolids has been restricted in neighboring counties and ecosystems to the south, such as the St. Lucie River watershed and the Lake Okeechobee watershed and a temporary moratorium in Indian River County, leaving the St. Johns River watershed in and adjacent to Brevard County as the next closest alternative up the east coast for the disposal and land application of Class B biosolids generated in South Florida; and

WHEREAS, phosphate concentrations are may continue to trend upward under new state rules with increasing tonnage coming from outside the County but being applied in the Upper Basin of the St Johns River, adjacent to our drinking water supply²; and

WHEREAS, increasing phosphate levels increase the risk of algal blooms, especially taxa that produce toxins such as microcystins and saxitoxins²; and

WHEREAS, Lake Washington and large portions of the Upper Basin of the St. Johns River are classified by the Florida Department of Environmental Protection as Class I surface waters with a designated use for potable water supplies²; and

WHEREAS, portions of the Upper Basin of the St Johns River have been designated as impaired and local jurisdictions including Brevard County and its taxpayers are required to reduce total phosphorus loading from the sum of sources by as much as 52%³; and

WHEREAS, approximately \$250 million has been invested in state and federal Upper Basin restoration work to restore historic flows and levels²; and

WHEREAS, the land application activities of Class B biosolids is currently being conducted on property in Brevard County, within the watershed of the St. Johns River; and

WHEREAS, adding to the present nutrient levels in the St. Johns River Basin may further inflict damage to the local economy as well as the health, safety, and welfare of humans and wildlife in Brevard County and the State of Florida; and

WHEREAS, in 2018 the Department of Environmental Protection created a Biosolids Technical Advisory Committee to evaluate the current management practices and explore opportunities to better protect Florida's water resources and the Committee agreed to a list of recommendations in January 2019; and

³ Florida Department of Environmental Protection TMDL Report: Nutrient and DO TMDLs for the St. Johns River above Lake Poinsett (WBID 2893L), Lake Hell n' Blazes (WBID 2893Q), and St Johns River above Sawgrass Lake (WBID 2893X), April 2006

WHEREAS, in 2019 the Florida Legislature considered several bills to address concerns regarding biosolids and implement recommendations of the Technical Advisory Committee; and

WHEREAS, the Department of Environmental Protection considered the recommendations of the Technical Advisory Committee to draft rule revisions ratified during the 2021 Legislative session; and

WHEREAS, the new biosolids rules ratified by the Legislature in 2021 increase water quality protections but still allow more phosphorus to be land applied per year than the amount of phosphorus anticipated to be removed by the harvest of crops; and

WHEREAS, the Board of County Commissioners ("Board") finds that the proper regulation of the land application of Class B biosolids is necessary and appropriate to protect potable water supplies as well as guide the future use, development, and protection of the land and natural resources in Brevard County; and

WHEREAS, the Board has determined that the temporary moratorium on new or expanding biosolids application is needed to protect water quality in Lake Washington, the St. Johns River watershed and surrounding water bodies, from adverse impacts potentially caused by the land application of Class B biosolids; and

WHEREAS, the owners of agricultural properties currently permitted to land apply Class B biosolids in Brevard County have implemented nutrient management plans and installed systems to collect drainage water and reuse it for irrigation, capturing and reusing excess nutrients draining from the farmland; and

WHEREAS, applying biosolids to pastureland amends the soils and recycles organic nutrients that are removed from the land each year by cattle and the harvest of sod; and

WHEREAS, the use of biosolids as fertilizer reduces the need for landfill space; and

WHEREAS, research has shown that organic sources of fertilizer such as biosolids are much less water soluble than commercial chemical fertilizer⁴; however, soil and water sampling indicate that the pasture land where Class B biosolids have been applied has exceeded its capacity to hold phosphorus and phosphorus is leaving those pasture lands and entering the St. Johns River during heavy rains⁵; and

WHEREAS, the Board enacted Ordinance 2019-20 imposing a 180-day temporary moratorium on any new Class B biosolids applications on October 8, 2019; and

WHEREAS, Section 403.0855(6), Florida Statutes (2020) allows for the extension of county moratoriums on the land application of Class B biosolids which were adopted prior to November 1, 2019; and

WHEREAS, The Board enacted Ordinance 2020-05 imposing a 180-day extension of the temporary biosolids moratorium on April 7, 2020; and

WHEREAS, The Board enacted Ordinance 2020-18 imposing a 180-day extension of the temporary biosolids moratorium on October 6, 2020; and

WHEREAS, The Board enacted Ordinance 2021-07 imposing a 180-day extension of the temporary biosolids moratorium on March 9, 2021; and

WHEREAS, The Board enacted Ordinance 2021-20 imposing a 180-day extension of the temporary biosolids moratorium on August 24, 2021; and

WHEREAS, the Board specifically finds that this extension to the temporary moratorium on the land application of Class B biosolids is necessary and appropriate to protect the public health safety and welfare of the citizens of Brevard County.

⁴ Silveira, M.L., G.A. O'Connor, Y. Lu, J. E. Erickson, C. Brandani and M. M. Kohmann, 2019. Runoff and Leachate Phosphorus and Nitrogen Losses from Grass-Vegetated Soil Boxes Amended with Biosolids and Fertilizer. *Journal of Environmental Quality*. doi: 10.2134/jeq2019.03.0106

⁵ Brevard County Sampling Report for the Land Application of Biosolids on Deer Park Ranch and Other Potential Impacts to Lake Washington Water Quality. Final Report 03-11-2020, Prepared by Applied Ecology, Inc.

NOW, THEREFORE, BE IT ORDAINED BY THE BOARD OF COUNTY COMMISSIONERS OF BREVARD COUNTY, FLORIDA THAT:

Section 1. Recitals Adopted

Each of the recitals set forth above is hereby adopted and incorporated herein.

Section 2. Enactment Authority.

Article VIII, Section 1 of the Florida Constitution and Chapter 125, Florida Statutes, vest broad home rule powers in counties to enact ordinances, not inconsistent with general or special law, for the purpose of protecting the public health, safety and welfare of the residents of the County. The Board specifically determines that the enactment of this Ordinance is necessary to protect the health, safety and welfare of the residents of Brevard County.

Section 3. Temporary Moratorium.

Beginning on the effective date of this Ordinance and continuing for a period of 180 days, a moratorium is hereby imposed upon all properties within Brevard County on the land application of Class B biosolids, excepting existing permit holders and where determined to be preempted by state law or regulation.

Section 4. Expiration of Temporary Moratorium.

The temporary moratorium imposed by Section 3 of this Ordinance expires 180 days from the effective date of this Ordinance. The moratorium may be extended or terminated early by adoption of an ordinance or resolution of the Brevard County Board of County Commissioners.

Section 5. Exhaustion of Administrative Remedies.

A property owner claiming that this Ordinance, as applied, constitutes or would constitute a temporary or permanent taking of private property or an abrogation of

vested rights shall not pursue such claim in court unless all administrative remedies have been exhausted.

Section 6. Severability.

If any part of this Ordinance is held to be invalid or unconstitutional by a court of competent jurisdiction, the remainder of this Ordinance shall not be affected by such holding and shall remain in full force and effect.

Section 7. Conflict.

All ordinances or parts of ordinances in conflict herewith are hereby repealed.

Section 8. Resolution of Conflicting Provisions.

In the case of a direct conflict between any provision of this Ordinance and a portion or provision of any other appropriate federal, state or county law, rule, code or regulations, the more restrictive shall apply.

Section 9. Area Encompassed.

This Ordinance shall take effect COUNTYWIDE, within the municipal and unincorporated areas of Brevard County, Florida.

Section 10. Effective Date.

This Ordinance shall become effective upon adoption by the Board of County Commissioners and filing with the Department of State. A certified copy of the Ordinance shall be filed with the State, within ten days of enactment.

[REMAINDER OF PAGE INTENTIONALLY LEFT BLANK.]

DONE, ORDERED AND ADOPTED in Regular Session, this 8 day of Feb. 2022.

Attest:

BOARD OF COUNTY COMMISSIONERS
OF BREVARD COUNTY, FLORIDA



Rachel Sadoff, Clerk



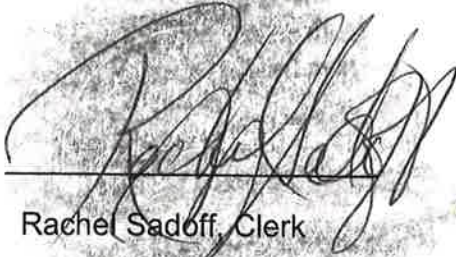
Kristine Zonka, Chair

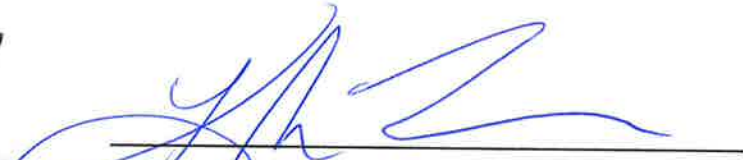
(As approved by the Board on Feb. 8, 2022)

DONE, ORDERED AND ADOPTED in Regular Session, this 8 day of Feb., 2022.

Attest:

BOARD OF COUNTY COMMISSIONERS
OF BREVARD COUNTY, FLORIDA



Rachel Sadoff, Clerk

Kristine Zonka, Chair

(As approved by the Board on Feb. 8, 2022)

MARCH 11, 2020



**BREVARD COUNTY SAMPLING REPORT
FOR THE LAND APPLICATION OF
BIOSOLIDS ON DEER PARK RANCH AND
OTHER POTENTIAL IMPACTS TO LAKE
WASHINGTON WATER QUALITY**

TASK ORDER # 215260-20-001-01



APPLIED ECOLOGY, INC.
122 Fourth Ave, Suite 104 Indialantic, FL 32903

EXECUTIVE SUMMARY

Lake Washington is an important source of drinking water to numerous cities and towns in the Melbourne region. Between July and August of 2019, Lake Washington experienced an algal bloom of the toxin producing cyanobacteria *Dolichospermum circinale*. Links between biosolid applications and harmful algal blooms have been investigated elsewhere in Florida. On October 8th, 2019, the Brevard County Commission voted to place a six-month moratorium on the expanded application of biosolids. In support of Brevard County's Biosolid Moratorium, Brevard County Natural Resources Management (BCNRM) contracted with Applied Ecology, Inc. to conduct a limited survey to determine levels of nutrients, metals, and emerging contaminants in water and vegetation in and around Lake Washington, including the Deer Park Ranch. Results from this present study will be used by the Commission to guide further regulatory action.

In total eleven locations were sampled for surface water between December 18-19, 2019, including five residential sampling locations east of Lake Washington, one location in Lake Washington, one location in the St. Johns River between Sawgrass Lake and Lake Washington and two locations southwest (upstream) of Lake Washington near where Class B biosolid applications have occurred and two locations in Jane Green swamp upstream of where biosolids have not been applied. In addition, three sites in the Deer Park Ranch were selected to sample plant tissue for pharmaceuticals.

For metals, none of the samples exceeded the drinking water standards. Arsenic, copper, molybdenum, nickel and zinc results ranged between < 0.5 to 2.4 parts per billion (ppb), <0.93 to 4.2 ppb, <0.5 to 3.1 ppb, <0.62 to 0.71 ppb, and <4.3 to 10.8 ppb, respectively. The highest copper values were observed near the ranch, while the highest arsenic and molybdenum values were observed in drainage canals east of Lake Washington.

For nutrients, ammonia, total kjeldhal nitrogen, nitrate-nitrite, total nitrogen, orthophosphate, and total phosphorous concentrations ranged between < 0.035 to 0.18 parts per million (ppm), 0.64 to 1.7 ppm, <0.33 to 0.15 ppm, 0.64 to 1.8 ppm, 0.0043 to 1.9 ppm and 0.028 to 2.2 ppm, respectively. The highest total nitrogen (TN) values were observed within Lake Washington; however, none of the discrete samples exceeded the numeric nutrient criteria (NNC) applicable to this segment of the St. Johns River. The highest total phosphorus (TP) values were observed in waters flowing off the ranch. Additionally, individual TP samples above the annual geometric means of the NNC (0.12 ppm) were observed at two ranch sites and one canal site east of Lake Washington. Low TN to TP ratio, which may favor nitrogen-fixing cyanobacteria over other algae, were observed at the two Deer Park Ranch sites (ratios of 0.6 and 0.9). These ratios were markedly lower than all other sites (ratio ranges of 4.5 to 16.9).

In addition to nutrients and metals, three sites east of Lake Washington, one site in Lake Washington, one location in the St. Johns River between Sawgrass Lake and Lake Washington, and two ranch sites were tested for a full suite of perfluoroalkyl substances (PFAS). PFAS make up a large group of persistent anthropogenic chemicals used in industrial processes and

commercial products over the past 60 years. Two of the PFAS compounds tested under this study (PFOS and PFOA) have been identified as having potential human health and/or environmental impacts. Although all sites had detectable levels of PFAS, only one site located east of Lake Washington had quantifiable levels of PFOS. The PFOS concentration at this site (40 parts per trillion or ppt) exceeded the provisional Perfluorooctanesulfonic acid (PFOS) FDEP Human Health Surface Water Screening Levels (4 ppt). However, no samples exceeded the EPA Lifetime Drinking Water Health Advisory nor the FDEP Ecological Surface Water Screening Levels for Perfluorooctanoic acid (PFOA) or PFOS.

Concentrations of 58 pharmaceuticals and personal care products (PPCPs) were also analyzed in two water samples and three plant tissue samples from the ranch. No PPCPs were detected in any of the water samples. In plant tissues, one of the samples had no PPCPs detected, while two samples had quantifiable concentrations of the anti-inflammatory drug Naproxen (0.322 and 0.713 ppb) and the antibiotic Ciprofloxacin (9.84 and 35.6 ppb). Additionally, one of the plant tissue samples had quantifiable levels of Triclocarban (an anti-microbial) and quantifiable levels of Norfloxacin (an antibiotic).

PROJECT BACKGROUND

Lake Washington is an important source of drinking water to numerous cities and towns in the Melbourne region including Melbourne, Melbourne Beach, West Melbourne, Indian Lake, Indian Harbour Beach, Satellite Beach, Palm Shores, Melbourne Village, and other parts of unincorporated Brevard County. Between July and August of 2019, Lake Washington experienced an algal bloom of the cyanobacteria *Dolichospermum circinale*. During this bloom event, water samples from the lake had Saxitoxin/Paralytic Shellfish Toxins between 0.06 - 0.11 ppb, below the drinking water guidelines of 3 ppb. Associations between biosolid application and harmful algal blooms (HAB) have been made in other areas along the St. Johns River (SJR).

Blue Cypress Lake, located in Indian River County, experienced a prolonged HAB during 2018. The lake, like other areas in the SJR Basin, saw an increase in Class B biosolid application after 2013 when such applications were banned from Lake Okeechobee, St. Lucie River and Caloosahatchee River basins. Blue Cypress Lake also experienced an increase in phosphorus levels in the surface water.

The land application of biosolids as a fertilizer for agricultural land provides Total Nitrogen (TN) and Total Phosphorus (TP) at a different ratio than most crops require. This can lead to the overapplication and accumulation of phosphorus and increased leaching into surrounding waterbodies. This is partially mitigated by a nutrient management plan as required in Chapter 62-640, F.A.C. An imbalance in the TN:TP ratio in surface waters can lead to the proliferation of

nitrogen-fixing, and potential HAB forming, cyanobacteria (Downing and McCauley, 1992; Dolman *et al.*, 2012).

In addition to nutrients, biosolids can be a potential source of metals (Wuana and Okieimen, 2011). For this reason, Chapter 62-640.700(5)(a), F.A.C. regulates biosolids for maximum concentrations of arsenic (75 mg/kg), copper (4,300 mg/kg), molybdenum (75 mg/kg), nickel (420 mg/kg) and zinc (7,500 mg/kg) as well as four other metals that commonly occur in Class B biosolids.

PFAS make up a large group of persistent anthropogenic chemicals used in industrial processes and commercial products over the past 60 years. As a result of concerns for these emergent compounds, recommended health advisory levels and provisional screening values for perfluorooctanesulfonic acid (PFOS) and/or perfluorooctanoic acid (PFOA) have been developed by the EPA and FDEP. PFAS have been found in biosolids worldwide (Bossi *et al.*, 2008; Chen *et al.*, 2012). Despite ceases in production of many PFAS-containing products, their concentrations in biosolids do not appear to have decreased (Vankatesan and Halden, 2013).

Like PFAS, pharmaceuticals and personal care products (PPCPs) are persistent chemicals which can bioaccumulate and cause deleterious effects on human and ecosystem health (Xia *et al.*, 2005; Richmond *et al.*, 2017). PPCPs have also been found in biosolids across the world, and special focus has been given to the potential for these compounds to bioaccumulate (Wu *et al.*, 2015). Unlike PFAS, there are currently no guidelines or health advisory levels for PPCPs.

Deer Park Ranch is a major (3,270 acres) permitted site which has been accepting land application of biosolids for 25 years, having accepted about 7,484 tons of biosolids in 2018. Part of the ranch's runoff enters into the St. Johns River, which flows north into Lake Washington. On October 8th, 2019, the Brevard County Commission voted to place a six-month moratorium on the expanded application of biosolids. In support of Brevard County's Biosolid Moratorium, Brevard County Natural Resources Management (BCNRM) contracted with Applied Ecology, Inc. to conduct a limited survey to determine levels of nutrients, metals, and emerging contaminants in water and vegetation in and around Lake Washington, including the Deer Park Ranch. In addition to the study by Applied Ecology, Inc., BCNRM collaborated with the University of Florida's Institute of Food and Agricultural Sciences (hereafter called UF), St. Johns River Water Management District, Brevard Soil & Water Conservation District, United States Department of Agriculture's Natural Resources Conservation Service, and Florida Department of Environmental Protection to conduct a study of phosphorus concentrations in soils on the Deer Park Ranch property. This soil study included the sampling and analysis of 50 soil samples within 11 pastures receiving different levels of biosolids application within the ranch, including two control samples. Results from this soil study will also be used by the Commission to guide further regulatory action.

METHODS

In early December 2019, Applied Ecology, Inc. worked closely with County staff to determine sampling locations to analyze potential nutrient and pollutant contributions to Lake Washington from biosolid applications along Deer Park Ranch as well as residential areas east of Lake Washington (Figures 1 and 2).

In total eleven locations were sampled for surface water between December 18-19, 2019, including five residential sampling locations east of Lake Washington, one location in Lake Washington, one location in the St. Johns River between Sawgrass Lake and Lake Washington and two locations southwest (upstream) of Lake Washington near where Class B biosolid applications have occurred and two locations in Jane Green swamp upstream of where biosolids have not been applied. In addition, three sites in the Deer Park Ranch were selected to sample plant tissue for pharmaceuticals. It should be noted that there was a significant (more than 1 inch) rainfall event the day prior to the sampling event.

In addition to common water quality parameters (pH, temperature, specific conductance and dissolved oxygen), additional analytes tested included metals (arsenic, copper, molybdenum, nickel, and zinc), nutrients (ammonia, total kjeldhal nitrogen, nitrate-nitrite, total nitrogen, orthophosphate and total phosphorous), 24 different perfluoroalkyl substances (PFAS), and 58 different pharmaceuticals and personal care products (PPCPs).

On or near the Deer Park Ranch (Figure 1), two of the locations (Site 1 and 2) were receiving water from natural land use areas. These sites were sampled from the same creek and were analyzed for nutrients and metals. Another two locations (Sites 3 and 4) were located in separate drainage canals near fields used for cattle pasture and sod farming, which received high biosolid loadings and flow out of the ranch during high rainfall conditions. These sites were analyzed for nutrients, metals, PFAS, and PPCPs. Also, within the Deer Park Ranch, three locations in fields (Plant Tissue 1, 2, and 3) had vegetative tissues sampled for PPCPs. Downstream of the Deer Park Ranch, on the St. Johns River (SJR), one site (Site 12) downstream of Highway 192 was sampled for nutrients, metals, and PFAS. Due to flooded roads and lack of accessibility, Site 10 was not able to be sampled and thus dropped from the analysis.

East of Lake Washington (Figure 2), all samples were taken from unnamed canals, including one site located upstream (Site 6) and another downstream (Site 5) of treatment ponds (and firefighting training facility). Site 5 was analyzed for nutrients, metals, and PFAS, while Site 6 was analyzed for nutrients and metals. Three sites (Sites 7, 8, and 9) were also located on canals draining residential areas. Sites 7 and 8 were analyzed for nutrients, metals, and PFAS, while Site 9 was analyzed for nutrients and metals. One site (Site 11) was taken in Lake Washington, south of the Melbourne Water Treatment Plant uptake near where the canal from Site 8 empties. This site was sampled for nutrients, metals, and PFAS.

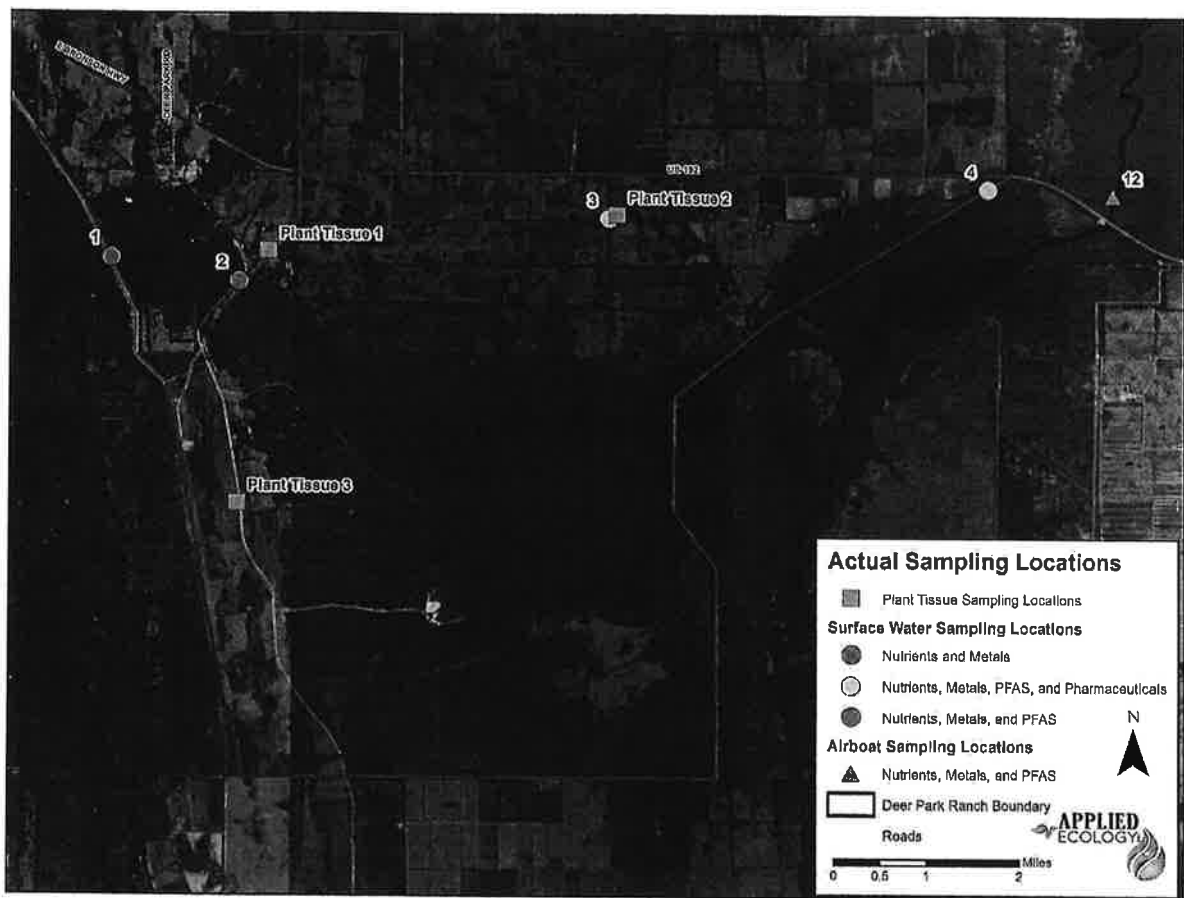


Figure 1. Site locations and parameters analyzed at five water quality and three plant tissue sites near the Deer Park Ranch where biosolids have been used for the last 25 years.

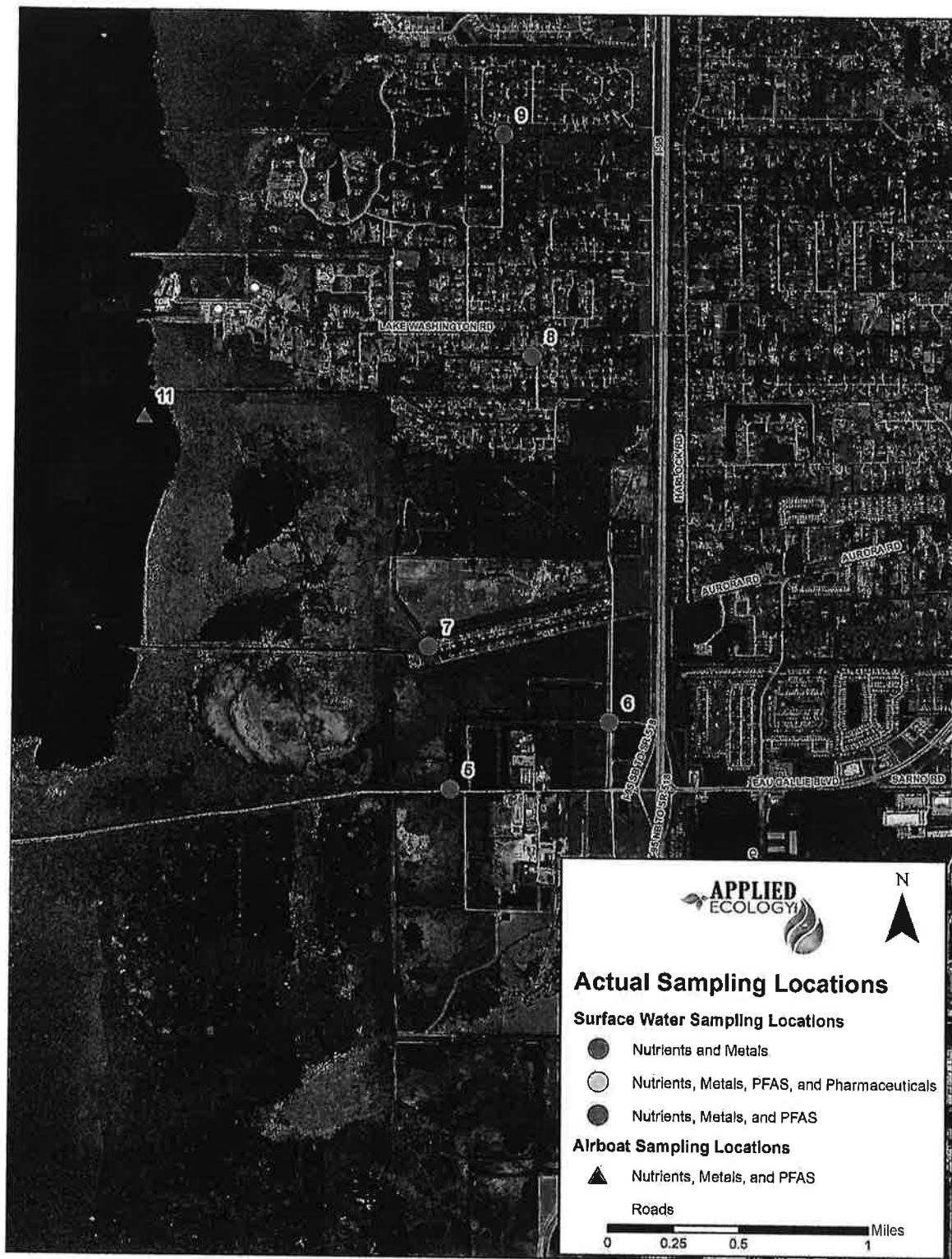


Figure 2. Sample locations and parameters analyzed at five water quality sites draining residential areas near Lake Washington and one site within Lake Washington.

All water quality sampling followed Florida Department of Environmental Protection (FDEP) Standard Operating Procedures (SOPs) FS 1000 and FS 2100. Water quality parameters measure *in situ* for Sites 1-4 were taken with a calibrated YSI, and Sites 5-12 were taken with a calibrated Ultrameter. All grab samples were collected using a peristaltic pump except for Site 2, which required a Van Dorn Sampler. For all sampling, precautions for cross-contamination were used, including for PFAS the use of new High-Density Polyethylene (HDPE) tubing to purge and collect surface water samples at each site as well as (for PFAS and PPCPs) a field blank.

Ammonia, Total Kjeldahl Nitrogen, Nitrate/Nitrite, and Total Phosphorus were collected in a 250 mL laboratory-provided container with sulfuric acid as preservative. Orthophosphate was collected in a 250 mL laboratory-provided container without preservative. Metals were collected in a 250 mL laboratory-provided container with nitric acid as preservative. Nutrient and metal samples were sent to Pace Analytical Services laboratory (Ormond Beach, FL) to process the following analytic measurements:

Nutrients

- EPA 350.1 - Ammonia
- EPA 351.2 - Total Kjeldahl Nitrogen (TKN)
- EPA 353.2 - Nitrate/Nitrite
- EPA 365.3 - Total Phosphorus (TP)
- EPA 365.1 - Orthophosphate

Metals

- EPA 200.8 – Arsenic (As), Copper (Cu), Molybdenum (Mo), Nickel (Ni) and Zinc (Zinc)

To sample for PFAS, two 125-mL aliquots were collected in a laboratory-provided container with no preservative, sealed, labeled, packed in ice, and shipped under chain-of-custody protocol to SGS Laboratories (Orlando, FL) for analysis of PFAS, including PFOA, PFOS, and 22 additional compounds using a modified EPA Method 537Mod.

To sample for PPCPs in water, two 500 mL aliquots were collected in a laboratory-provided container. For plant tissues, 40 to 50 g of vegetative tissue (Bahia grass at Site 1 and 3 and *Hemarthria* grass at Site 2) was collected in a laboratory-provided container. The samples were with no preservative, sealed, labeled, packed in ice, and shipped under chain-of-custody protocol to SGS Laboratories (Sidney, Canada) for analysis of 58 pharmaceuticals and personal care products using AXYS Method MLA-075 (modified EPA Method 1694).

See Appendix A for additional information regarding the sampling sites.

RESULTS

Surface Water Grabs

Applied Ecology, Inc. (AEI) went to 11 sites for surface water sampling. Field parameters collected *in situ* include the depth the sample/readings were taken in meters, air and water temperature (°C), the pH (SU), the dissolved oxygen percentage (DO), the specific conductance (µS/cm), total dissolved solids and oxidation-reduction potential, which are provided in Table 1. Complete corresponding field and calibration logs are included in Appendix B. The water was circumneutral with temperatures ranging between 17°C and 20.2°C. Specific conductance and total dissolved solids (TDS) ranged between 0.175-1.089 µS/cm and 371.7-765.3, respectively. The highest specific conductance and TDS were observed at Site 9 and may have been elevated at all spots due to precipitation preceding the sampling event.

Table 1. Field parameters measured during the surface water sampling for the Brevard County Biosolids Monitoring.

Site ID	Sample Date	Total Depth of Water (m)	Air Temp (°C)	Water Temp (°C)	pH (SU)	DO (%)	Specific Conductance (µS/cm)	Total Dissolved Solids (ppm)	Oxidation Reduction Potential (mV)	Sample Depth (m)
1	12/18/2019	> 2	17.6	20	7.76	22.3	0.1757	NA	NA	0.5
2	12/18/2019	> 2	16.6	20.2	7.07	37.1	0.1784	NA	NA	0.5
3	12/18/2019	0.3	14.5	19.9	7.24	56.5	0.3670	NA	NA	0.15
4	12/18/2019	NA	13.5	19.9	7.31	33.4	0.8460	NA	NA	0.5
5	12/19/2019	1.5	13.5	16.5	7.99	NA	0.9208	642.3	67	0.5
6	12/19/2019	1	19.5	19.5	7.48	NA	0.6889	471.1	102	0.5
7	12/19/2019	NA	18.8	19.4	7.77	NA	0.6605	451.4	112	0.5
8	12/19/2019	1	18.8	19	7.42	NA	0.9272	643.5	61	0.5
9	12/19/2019	0.25	18	17.1	7.47	NA	1.089	765.3	54	0.15
11	12/19/2019	>2	16.3	17	7.69	NA	0.7202	496.3	73	0.5
12	12/19/2019	>2	17.8	18.1	7.80	NA	0.5463	371.7	160	0.5

Metals

Applied Ecology, Inc. sampled 11 sites for metals (arsenic, copper, molybdenum, nickel, and zinc) and compared results to the applicable surface water criteria defined in Chapter 62-302, F.A.C. Hardness was not measured concurrently with metals, so low and high hardness values of 25 and 400 mg/L calcium carbonate (CaCO_3) as outlined in 62.302-530[1] were presented in Table 2 for illustrative purposes. For quality assurance, a field reagent blank was also collected, which exhibited concentrations below laboratory MDL values for all five metals. Complete laboratory analytical results from the one-time sampling for metals can be found in Appendix C.

No metals were detected at Site 1 (Table 2). Site 2 only had detectable levels of zinc, but it had the highest observed zinc concentrations (24.0 $\mu\text{g/L}$), more than twice as much as the next highest levels observed at Site 3 and Site 9 (10.8 $\mu\text{g/L}$). Site 3 had detectable values of all analytes except for nickel, with quantifiable levels of molybdenum (1.8 $\mu\text{g/L}$), zinc (10.8 $\mu\text{g/L}$), and the highest value of copper (4.2 $\mu\text{g/L}$). Although this copper value is above the low hardness criteria of 2.85 $\mu\text{g/L}$, it is unlikely to be an exceedance due to the historically high hardness values observed in other waterbodies in the area. All residential sites (Sites 5-9) had quantifiable values of molybdenum, which does not have applicable water quality standards. Additionally, residential sites 7-11 had quantifiable levels of arsenic (1.3 to 2.4 $\mu\text{g/L}$) well below the drinking water quality standard of 10 $\mu\text{g/L}$. In fact, all samples had metal concentration values below the drinking water quality standards in Chapter 62-550, F.A.C. assuming high water hardness values.

Table 2. Metal results (in µg/L) for the eleven sites sampled for the Brevard County Biosolids Moratorium Monitoring as well as the applicable FDEP criteria target levels (in µg/L) for each analyte as defined in Chapter 62-302, F.A.C. Samples with concentration values above the minimum detection level (MDL) but below the practical quantitation limit (PQL) are italicized, values above the PQL are bolded, and values above the applicable FDEP criteria target levels (in µg/L) are highlighted in grey.

Metals	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 11 ⁴	Site 12 ⁴	FDEP Class I Criteria (Low)	FDEP Class I Criteria (High)	FDEP Class III FW Criteria (Low)	FDEP Class III FW Criteria (High)
Arsenic	0.50 U ¹	0.50 U ¹	0.64 <i>p²</i>	0.54 <i>p²</i>	0.76 <i>p²</i>	0.67 <i>p²</i>	1.80	2.00	2.40	1.30	0.52 <i>p²</i>	10	10	50	50
Copper	0.93 U ¹	0.93 U ¹	4.20 ⁵	0.93 U ¹	0.93 U ¹	1.00	0.93 U ¹	1.80	0.93 U ¹	1.40	0.93 U ¹	2.85	30.5	2.85	30.5
Molybdenum	0.50 U ¹	0.50 U ¹	1.80	0.50 U ¹	2.50	2.30	3.10	1.30	1.80	1.60	0.98 <i>p²</i>	NA	NA	NA	NA
Nickel	0.62 U ¹	0.62 U ¹	0.62 U ¹	0.62 U ¹	0.62 U ¹	0.62 U ¹	0.62 U ¹	0.62 U ¹	0.62 U ¹	0.71 <i>p²</i>	0.62 U ¹	16.1	168.5	16.1	168.5
Zinc	4.30 U ¹	24.0	10.8	4.30 U ¹	4.30 U ¹	5.30	4.30 U ¹	9.10	10.8	5.20	4.30 U ¹	37.0	387.8	37.0	387.8

¹ "U" qualified values indicate the analytical concentration is below laboratory MDLs; limits vary depending on parameter and sample

² "I" qualified values indicate the analytical concentration is greater than or equal to the MDL, but less than the PQL

³ Values from Chapter 62-304.530 F.A.C. Copper, nickel, and zinc are hardness based with "Low" being set to a hardness of 25 mg/L of CaCO₃ and "High" set to 400 mg/L of CaCO₃

⁴ Class I waters

⁵ Value could be above Class I most stringent criteria if hardness is considered low onsite (less than 25 mg/L of CaCO₃)

Nutrients

Applied Ecology, Inc. sampled 11 sites for the following nutrients: ammonia, total kjeldhal nitrogen, nitrate-nitrite, total nitrogen (TN), orthophosphate, and total phosphorous (TP). Results are summarized in Table 3. Complete laboratory analytical results from the one-time sampling for nutrients can be found in Appendix C.

The highest orthophosphate (1.9 mg/L and 0.86 mg/L) and TP (2.2 mg/L and 0.95 mg/L) values were observed at Site 3 and 4 respectively. The highest ammonia (0.18 mg/L) values were observed at Site 9, while Site 11 (within Lake Washington) had the highest values of TN (1.8 mg/L), total kjeldahl nitrogen (1.7 mg/L) and nitrate-nitrite (0.15 mg/L). Based on only two data points (Sites 6 and 5), the stormwater treatment ponds may be decreasing, TN, ammonia, total kjeldhal nitrogen, nitrate-nitrite, orthophosphate and TP by as much as 26.4%, 49.3%, 16.9%, 67.0%, 53.8%, and 26.3%, respectively.

Table 3. Nutrient results (in mg/L) for the eleven sites sampled for the Brevard County Biosolids Moratorium Monitoring and applicable FDEP criteria (in mg/L) for each analyte. Samples with concentration values above the applicable criteria are highlighted in grey.

Nutrient Analyte	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 11	Site 12	FDEP NNC for Lake Washington	FDEP NNC for Streams
Total Nitrogen	0.980	1.000	1.300	0.820	0.640	0.870	0.860	0.970	1.200	1.800	1.300	1.91	1.54
Ammonia	0.035 U ¹	0.035 U ¹	0.060	0.035 U ¹	0.035 U ¹	0.069	0.035 U ¹	0.068	0.180	0.081	0.035 U ¹	NA	NA
Total Kjeldahl Nitrogen	0.980	1.000	1.300	0.800	0.640	0.770	0.860	0.830	1.200	1.700	1.300	NA	NA
Nitrate-Nitrite	0.033 U ¹	0.033 U ¹	0.058	0.033 U ¹	0.033 U ¹	0.100	0.033 U ¹	0.140	0.060	0.150	0.033 U ¹	NA	NA
Ortho-phosphate	0.035	0.028	1.900	0.860	0.004	0.009	0.007	0.086	0.055	0.050	0.077	NA	NA
Total Phosphorus	0.063	0.059	2.200	0.950	0.028	0.038	0.053	0.130	0.100	0.110	0.120	0.16	0.12
Nitrogen to Phosphorus Ratio (TN:TP)	15.6	16.9	0.6	0.9	22.9	22.9	16.2	7.5	12.0	16.4	10.8	NA	NA

¹ "U" qualified values indicate the analytical concentration is below laboratory minimum detection limits (MDLs); limits vary depending on parameter and sample

PFAS

Applied Ecology, Inc. (AEI) sampled seven sites for PFAS and compared the surface water PFOA and PFAS laboratory measured results to the 0.070 µg/L EPA lifetime drinking water health advisory (LDWHA) for PFOA and PFOS (Table 4). Additionally, AEI compared the results to FDEP provisional screening values for Human Health in Surface Water (HHSW) and Ecological Health in Surface Water (EHSW). For quality assurance, a field reagent blank was also collected, which exhibited concentrations below laboratory MDL values for all 24 PFAS compounds. Complete laboratory analytical results from the one-time sampling for PFAS can be found in Appendix D.

All sites had detectable levels of PFAS, with Perfluorobutanesulfonic acid (PFBS) and Perfluorobutanoic acid (PFBA) detected at all seven sites analyzed for PFAS. However, only four sites had quantifiable levels of PFAS. Sites 3 and 4, which are on Deer Park Ranch in canals that receive runoff from high biosolid loading areas, had quantifiable levels of PFBA (0.0164 and 0.0210 µg/L, respectively), Perfluoropentanoic acid (0.0230 and 0.0130 µg/L, respectively), Perfluorohexanoic acid (0.0121 and 0.0081 µg/L, respectively) and PFBS (0.0520 and 0.0360 µg/L, respectively). Even though many of the PFAS do not have current recommended health advisories or screening health advisories, there are recent toxicological studies that do indicate potential of other PFAS besides PFOA and PFOS, such as PFBS having development, thyroid, and kidney effects in adult and developing rats (Feng *et al.*, 2017). Site 8, which was in a canal that receives runoff from residential areas, had quantifiable levels of Perfluoropentanoic acid (0.0084 µg/L). Site 5, located downstream of the treatment ponds that also receives runoff from the Brevard County Fire Rescue Drill Yard and potentially other commercial and industrial land uses, had quantifiable levels of four PFAS: PFBA (0.0183 µg/L), Perfluorohexanoic acid (0.0095 µg/L), Perfluorohexanesulfonic acid (0.0377) and PFOS (0.0398 µg/L). This site was the only site to have quantifiable values of Perfluorohexanesulfonic acid and PFOS and was also the only site to exceed the provisional FDEP HHSW for PFOS (0.004 µg/L).

Site 7, which was located in a canal that receives runoff from residential areas, appears to have the lowest number of detections, only PFBS and PFBA were detected, but not in sufficient concentration to quantify. Sites 11 (Lake Washington) and 12 (St. Johns River) had 5 PFAS above detection limits, but not in sufficient concentration to quantify.

The following 14 PFAS were analyzed but not detected in any of the sample sites: Perfluorononanoic acid, Perfluorodecanoic acid, Perfluoroundecanoic acid, Perfluorododecanoic acid, Perfluorotridecanoic acid, Perfluorotetradecanoic acid, Perfluoropentanesulfonic acid, Perfluorononanesulfonic acid, Perfluorodecanesulfonic acid, Perfluorooctane sulfonamide, MeFOSAA, EtFOSAA, 4:2 Fluorotelomer sulfonate, 6:2 Fluorotelomer sulfonate and 8:2 Fluorotelomer sulfonate.

Table 4. Surface water PFAS analytical results (in µg/L) for Brevard County Biosolids Moratorium Monitoring and associated target cleanup levels (in µg/L) for each compound. Samples with concentration values above the minimum detection level (MDL) but below the practical quantitation limit (PQL) are italicized, values above the PQL are bolded. Values that exceeded the provisional FDEP Surface Water Screening Levels for Human Health (HHSW) or the US EPA Lifetime Drinking Water Health Advisory (LDWHA) are bolded and highlighted in grey.

PFAS Compound	Site 3	Site 4	Site 5	Site 7	Site 8	Site 11	Site 12	EPA LDWHA ³	FDEP HHSW ⁴	FDEP EHSW ⁵
Perfluorobutanoic acid (PFBA)	0.016	0.021	0.018	<i>0.006</i> <i>f²</i>	<i>0.011</i> <i>f²</i>	<i>0.011</i> <i>f²</i>	<i>0.010</i> <i>f²</i>	NA	NA	NA
Perfluoropentanoic acid (PFPeA)	0.023	0.013	<i>0.008</i> <i>f²</i>	<i>0.0023</i> <i>U¹</i>	0.008	<i>0.005</i> <i>f²</i>	<i>0.005</i> <i>f²</i>	NA	NA	NA
Perfluorohexanoic acid (PFHxA)	0.012	0.008	0.010	<i>0.002</i> <i>U¹</i>	<i>0.006</i> <i>f²</i>	<i>0.003</i> <i>f²</i>	<i>0.002</i> <i>f²</i>	NA	NA	NA
Perfluoroheptanoic acid (PFHpA)	<i>0.006</i> <i>f²</i>	<i>0.004</i> <i>f²</i>	<i>0.004</i> <i>f²</i>	<i>0.002</i> <i>U¹</i>	<i>0.003</i> <i>f²</i>	<i>0.002</i> <i>U¹</i>	<i>0.002</i> <i>U¹</i>	NA	NA	NA
Perfluorooctanoic acid (PFOA)	<i>0.008</i> <i>f²</i>	<i>0.006</i> <i>f²</i>	<i>0.006</i> <i>f²</i>	<i>0.002</i> <i>U¹</i>	<i>0.004</i> <i>f²</i>	<i>0.003</i> <i>f²</i>	<i>0.003</i> <i>f²</i>	0.07	0.15	1,300
Perfluorobutanesulfonic acid (PFBS)	0.052	0.036	<i>0.008</i> <i>f²</i>	<i>0.002</i> <i>f²</i>	<i>0.006</i> <i>f²</i>	<i>0.005</i> <i>f²</i>	<i>0.006</i> <i>f²</i>	NA	NA	NA
Perfluorohexanesulfonic acid (PFHxS)	<i>0.002</i> <i>U¹</i>	<i>0.002</i> <i>U¹</i>	0.038	<i>0.002</i> <i>U¹</i>	<i>0.002</i> <i>f²</i>	<i>0.002</i> <i>U¹</i>	<i>0.002</i> <i>U¹</i>	NA	NA	NA
Perfluoroheptanesulfonic acid	<i>0.002</i> <i>U¹</i>	<i>0.002</i> <i>U¹</i>	<i>0.002</i> <i>f²</i>	<i>0.002</i> <i>U¹</i>	<i>0.002</i> <i>U¹</i>	<i>0.002</i> <i>U¹</i>	<i>0.002</i> <i>U¹</i>	NA	NA	NA
Perfluorooctanesulfonic acid (PFOS)	<i>0.003</i> <i>f²</i>	<i>0.003</i> <i>U¹</i>	0.040	<i>0.003</i> <i>U¹</i>	<i>0.008</i> <i>f²</i>	<i>0.003</i> <i>U¹</i>	<i>0.003</i> <i>U¹</i>	0.07	0.004	37
PFOA + PFOS	<i>0.011</i> <i>f²</i>	<i>0.009</i> <i>f², U¹</i>	0.046	<i>0.005</i> <i>U¹</i>	<i>0.012</i> <i>f²</i>	<i>0.006</i> <i>f², U¹</i>	<i>0.006</i> <i>f², U¹</i>	0.07	NA	NA

¹ "U" qualified value indicates that analytical concentration is below laboratory MDLs; limits vary depending on parameter and sample

² "f" qualified value indicated the analytical concentration is greater than or equal to the MDL, but less than the PQL

³ US EPA Lifetime Drinking Water Health Advisories

⁴ Provisional Florida DEP Surface Water Screening Levels for Human Health

⁵ Provisional Florida DEP Surface Water Screening Levels for Ecological Health

Pharmaceuticals and Personal Care Products (PPCPs)

Surface Water

Applied Ecology, Inc. sampled two sites for 58 PPCPs (Sites 3 and 4, located on the Deer Park Ranch). For quality assurance, a field reagent blank was also collected, which exhibited concentrations below laboratory MDL values for all 58 compounds. None of the surface water samples had detectable PPCPs. Complete laboratory analytical results from the one-time sampling for PPCPs in surface water can be found in Appendix E.

Vegetation Tissue

Applied Ecology, Inc. sampled three sites with high biosolid loadings for 58 PPCPs (Plant Tissue 1-3). Complete laboratory analytical results from the one-time sampling for PPCPs in plant tissue can be found in Appendix F.

Plant Tissue 1 and 3 were Bahiagrass (*Paspalum notatum*) and actively or recently used for cattle grazing while Plant Tissue 2 was *Hemarthria sp.* collected in a field that was fallowed at time of sampling. Additionally, Plant Tissue 3 is located near the designated biosolids storage area. No pharmaceuticals were detected in Plant Tissue 2 (Table 5). Plant Tissue 1 and 3 both had quantifiable concentrations of the anti-inflammatory drug Naproxen (0.322 and 0.713 ppb, respectively) and the antibiotic Ciprofloxacin (9.84 and 35.6 ppb, respectively). Additionally, Plant Tissue 3 had 0.324 ppb of Triclocarban (an anti-microbial) and the other had 55.3 ppb of Norfloxacin (an antibiotic).

The following PPCPs were not detected in any of the tissue samples: Bisphenol A, Furosemide, Gemfibrozil, Glipizide, Glyburide, Hydrochlorothiazide, 2-hydroxy-ibuprofen, Ibuprofen, Triclosan, Warfarin, Acetaminophen, Azithromycin, Caffeine, Carbadox, Carbamazepine, Cefotaxime, Clarithromycin, Clinafloxacin, Cloxacillin, Dehydronifedipine, Diphenhydramine, Diltiazem, Digoxin, Digoxigenin, Enrofloxacin, Erythromycin-H₂O, Flumequine, Fluoxetine, Lincomycin, Lomefloxacin, Miconazole, Norgestimate, Ofloxacin, Ormetoprim, Oxacillin, Oxolinic acid, Penicillin G, Penicillin V, Roxithromycin, Sarafloxacin, Sulfachloropyridazine, Sulfadiazine, Sulfadimethoxine, Sulfamerazine, Sulfamethazine, Sulfamethizole, Sulfamethoxazole, Sulfanilamide, Sulfathiazole, Thiabendazole, Trimethoprim, Tylosin, Virginiamycin M1 and 1,7-Dimethylxanthine.

Table 5. Plant tissue analytical results (in ng/g) for Pharmaceuticals and Personal Care Products as part of the Brevard County Biosolids Moratorium Monitoring. No detectable results were found for Plant Tissue 2.

PPCP Analyte	Plant Tissue 1	Plant Tissue 2	Plant Tissue 3
Naproxen	0.322	0.313 ND ¹	0.713
Triclocarban	0.313 ND ¹	0.313 ND ¹	0.324
Ciprofloxacin	9.84	2.54 ND ¹	35.6
Norfloxacin	27.1 ND ¹	5.86 ND ¹	55.3

¹ ND - Non detect

CONCLUSION

A total of eleven water quality stations and three plant tissue sites were sampled between December 18 and 19, 2019. None of the eleven sites sampled exceeded the drinking water standards for the metals arsenic, copper, molybdenum, nickel, and zinc. The two ranch sites of the eleven sites sampled were above the numeric nutrient criteria (which is an annual geometric mean) for total phosphorus. PFAS were detected in all seven sites sampled, with one non-ranch site exceeding the provisional FDEP Human Health Surface Water Screening Levels for PFOS. PPCPs were not detected in the two water quality samples tested. However, of the three plant tissues sampled, two had high enough concentrations of four PPCPs to be quantifiable. Currently, there are no governmental guidelines for PPCPs in plant tissue.

An objective of the present study was to analyze presence, quantities, and contributions of nutrients and pollutants (metals, PPCPs, and PFAS) to the St. Johns River (Site 12) and Lake Washington (Site 11) from areas of biosolid application (Sites 3 and 4 and Plant Tissues 1-3) and residential areas (Sites 5-9). It should be emphasized that this was a small-scale study, with only one sample taken from each site over a two-day period, therefore conclusions are limited. Furthermore, loads from these two different land use types cannot be calculated as flows were not measured so. However, the present study has produced some notable results.

For metals, the highest copper value was observed at a site near biosolid application, while the other site near biosolid application did not have detectable copper. Copper is frequently found in biosolids as it readily associates with organic matter and according to Chapter 62-640.700(5)(a), F.A.C. copper in Class B biosolids can have a maximum single sample concentration of 4,300 mg/kg. However, considering the two sites both receive runoff from high biosolid loading areas, the results are inconclusive. The highest zinc value was found downstream of a bridge in a natural land use area. This higher concentration than other sites could be related to the use of galvanized steel in the bridge's construction.

For nutrients, Site 5 generally had the lowest nutrient concentrations and is downstream of a treatment pond. The highest nitrogen species concentrations were observed in Lake Washington, with generally higher values observed in the residential areas compared to natural land use areas. Nitrogen loading is typically associated with higher density residential and commercial land uses, typical of the basin draining from the east of Lake Washington. The highest TP, orthophosphate, and TN:TP values were observed at the two sites draining biosolid application areas. Generally, biosolid TN:TP is below the preferable ratio needed for plant growth (*i.e.*, crops) and when biosolids are applied on a need for nitrogen basis, it leads to excessive phosphorus build-up. The lower TN:TP has been observed in other lakes receiving runoff from biosolids application areas and has resulted in the banning of Class B biosolid applications in Lake Okeechobee, St. Lucie River and Caloosahatchee River watersheds. It is generally accepted that it is this low TN to TP ratio that leads to the proliferation of nitrogen-fixing cyanobacteria.

Although PFAS were detected in all samples, the only sample exceeding the provisional FDEP Human Health Surface Water Screening Levels was at Site 5, which is downstream of a firefighting training facility and a mix of high density residential and industrial and commercial land uses. In addition, a few months preceding the sampling date, a brush fire occurred closely near the sampling location (*i.e.*, NE of the Eau Gallie/I-95 interchange), where different firefighting products might have been used. PFOS have historically been added to aqueous film forming foam (AFFF) used to fight fires. AFFF was phased out of production in 2003 but has been used in Florida training facilities as recently as 2017. Currently, Class B firefighting foam used in Brevard County for flammable liquids such as gasoline, oils, etc., typically still contain C6 Fluorosurfactants, which have better toxicological profiles than PFOS (a C8 fluorosurfactant) but do persist in the environment.

Site 5 had quantifiable levels of PFOS, PFHxA (C6 fluorosurfactant primary breakdown product), and PFHxS. Rotander *et al.* (2015) found that both PFOS and PFHxS levels were shown to be elevated in firefighters exposed to AFFF. Sites 3 and 4, both receiving runoff from high biosolid application areas, had quantifiable concentrations of PFBA, PFPeA, PFHxA, and PFBS. These four PFAS are commonly (60-100% of the time) found in biosolids and, despite many being phased out, continue to be observed in similar concentrations in biosolids (Venkatesan and Halden 2013).

While PPCPs were detected in two tissue samples extracted from areas where high intensity of biosolids were applied, no PPCPs were detected in the water samples leaving the ranch at Sites 3 and 4. The lack of detectable PPCPs in the surface water samples could be due to the dilution effect of a very high rainfall event immediately preceding the sampling effort. Additionally, the PPCPs were only detected in areas of recent or active grazing (Plant Tissue 1 and 3) and not on land amended with biosolids, but currently fallow (Plant Tissue 2). While both ciprofloxacin and norfloxacin are antibiotics commonly used on cattle, the landowner of the Deer Park Ranch confirmed that neither antibiotic had been used recently on his cattle. Naproxen is a nonsteroidal anti-inflammatory drug found in common pain-relieving medications (Topp *et al.*, 2008), also confirmed to not have been used onsite by the landowner. Furthermore, no evidence could be found that naproxen is ever used on bovines. Topp *et al.* (2008) showed that naproxen is rapidly mineralized in soils amended with biosolids while Lin and Reinhard (2005) found naproxen rapidly photodegrades after release into the environment. Therefore, recently applied biosolids is the likely source for this particular compound. Triclocarban, originally developed for the medical field, is an antimicrobial and antifungal compound that was formerly used in personal care products such as soaps and lotions. The product began being used in the 1960s but was phased out by the FDA in 2017. Several studies have found that triclocarban from biosolid-amended fields can bioaccumulate in plants (Wu *et al.* 2010; Sabourin *et al.*, 2012; Wu *et al.*, 2014) and the concentrations observed in Site 3 were on the lower end of the range published in these studies. However, studies show the biosolid amendment inhibit the bioavailability and plant uptake of triclocarban (Fu *et al.*, 2016), which means concentrations in soils are likely much higher. In

general, the highest concentrations of PPCPs and the sample that had the most PPCPs was Plant Tissue 3. A potential confounding factor is differential bioaccumulation in vegetative tissues since Plant Tissue 1 and 3 were Bahiagrass while Plant Tissue 2 was *Hemarthria sp.*

The results from this limited study, in conjunction with a soil study by an interagency team, will be used by the Brevard County Commission to guide further regulatory action regarding biosolid applications in Brevard County.

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SAMPLE ID	PASTURE ID	DEPTH	SOIL TYPE	RELATIVE LEVEL OF BIOSOLIDS APPLICATION	MOST RECENT APPLICATION	MEHLICH PHOSPHORUS (ppm)	CALCIUM (ppm)	ALUMINUM (ppm)	IRON (ppm)	WATER EXTRACTABLE PHOSPHORUS (ppm)	TOTAL PHOSPHORUS (ppm)	CAPACITY FACTOR or SOIL PHOSPHORUS INDEX (SPSC)	pH	SAMPLE ID
1	11	Shallow	Myakka fine sand	High	Apr-18	178	1640	3.08	2.71	22.87	255.51	-177	6.8	1
2	11	Medium	Myakka fine sand	High	Apr-18	256	636	12.26	6.77	20.67	174.79	-254	6.9	2
3	11	Shallow	Wabasso fine sand	High	Apr-18	232	1197	4.92	5.22	24.22	302.66	-231	6.5	3
4	11	Medium	Wabasso fine sand	High	Apr-18	245	789	15.75	4.01	21.17	215.52	-243	7.1	4
5	11	Deep	Wabasso fine sand	High	Apr-18	5	238	64.11	72.54	0.94	22.31	6	8.2	5
6	37A	Shallow	Myakka fine sand	High	Nov-19	79	875	3.5	2.91	17.02	137.62	-78	5.9	6
7	37A	Medium	Myakka fine sand	High	Nov-19	16	126	1.8	1.43	4.4	9.2	-16	5.6	7
8	Timberland	Shallow	Control 1	None	-	7	359	16.09	4.55	0.99	24.4	-5	6.1	8
9	Timberland	Medium	Control 1	None	-	2	233	35.61	26.65	0.19	18.9	4	6.6	9
10	Timberland	Deep	Control 1	None	-	2	246	58.84	38.45	0.33	16.32	7	6.7	10
11	Timberland	Shallow	Control 2	None	-	2	277	2.4	1.43	3.64	25.59	-2	5.3	11
12	Timberland	Medium	Control 2	None	-	1	131	2.52	1.42	0.99	5.95	-1	4.9	12
13	37A	Shallow	Immokalee fine sand	High	Nov-19	64	1282	1.07	0.95	5.09	106.3	-64	6.5	13
14	37A	Medium	Immokalee fine sand	High	Nov-19	19	535	0.94	0.6	1.56	22.24	-19	6.7	14
15	37A	Deep	Immokalee fine sand	High	Nov-19	6	121	0.74	0.77	1.34	8.12	-6	6.4	15
16	36	Shallow	Wabasso fine sand	Low	Nov-18	278	921	3.48	5.4	19.63	332.12	-277	6.7	16
17	36	Medium	Wabasso fine sand	Low	Nov-18	51	351	26.1	14.26	24.79	204.82	-47	7.5	17
18	36	Deep	Wabasso fine sand	Low	Nov-18	12	180	26.56	28.31	12.05	124.32	-7	7.7	18
19	42	Shallow	Riviera sand	Low	Feb-19	50	574	9.5	7.01	9.58	95.22	-49	6.7	19
20	42	Medium	Riviera sand	Low	Feb-19	17	353	37.8	10.28	1.93	27.48	-12	7.1	20
21	42	Deep	Riviera sand	Low	Feb-19	2	337	26.72	5.24	0.57	11.58	1	8.3	21
22	33	Shallow	Wabasso fine sand	Medium	Dec-17	152	645	16.72	6.82	18.22	182.51	-150	6	22
23	33 Furrow, surface	Shallow	Wabasso fine sand	Medium	Dec-17	142	636	18.31	7.68	14.68	131.34	-139	6.2	23
24	33	Medium	Wabasso fine sand	Medium	Dec-17	31	532	39.2	7.27	6.34	54.32	-26	7.1	24
25	33	Deep	Wabasso fine sand	Medium	Dec-17	30	673	44.17	10.41	5.46	49.5	-24	7.3	25
26	33	Shallow	Riviera sand	Medium	Dec-17	52	342	6	2.28	12.85	126.92	-51	4.9	26
27	33 Furrow, surface	Shallow	Riviera sand	Medium	Dec-17	57	325	5.44	1.46	10.09	116.3	-56	5.1	27
28	33	Medium	Riviera sand	Medium	Dec-17	142	182	18.61	2.73	12.97	118.36	-140	4.8	28
29	27	Shallow	Florida sand	Medium	Jan-18	30	1738	8.49	2.86	6.24	100.29	-29	6.7	29
30	27	Medium	Florida sand	Medium	Jan-18	4	590	45.4	7.89	0.41	18.47	2	6.8	30
31	27	Shallow	Riviera sand	Medium	Jan-18	50	669	26.02	8.03	7.97	64.58	-47	6.6	31
32	27	Medium	Riviera sand	Medium	Jan-18	22	866	35.22	6.43	1.64	39.75	-18	7	32
33	15	Shallow	Riviera sand	High	Sep-19	236	3899	15.33	8.35	12.35	753.32	-234	7.4	33

34	15	Medium	Riviera sand	High	Sep-19	6	301	54.72	14.3	2.01	30.27	1	7.6	34
35	15	Deep	Riviera sand	High	Sep-19	5	350	29.21	9.24	1.21	18.78	-1	8.2	35
36	15	Shallow	Pineda sand	High	Sep-19	615	6656	5.02	3.71	15.99	1730.73	-614	7.3	36
37	15	Medium	Pineda sand	High	Sep-19	15	414	22.48	8.95	4.64	87.97	-12	7.7	37
38	15	Deep	Pineda sand	High	Sep-19	4	325	36.32	5.85	0.48	20.88	0	8.2	38
39	12	Shallow	Riviera find sand	Medium	Apr-18	168	1216	8.1	9.22	14.85	216.35	-167	7	39
40	12	Medium	Riviera find sand	Medium	Apr-18	13	170	18.72	4.53	5.53	37.97	-11	8.1	40
41	12	Deep	Riviera find sand	Medium	Apr-18	13	121	26.94	15.74	7.74	30.81	-9	8.4	41
42	12	Shallow	Wabasso fine sand	Medium	Apr-18	75	1091	2.52	8.58	9.67	116.19	-74	6.5	42
43	12	Medium	Wabasso fine sand	Medium	Apr-18	40	1025	3.01	5.74	4.2	76.78	-39	6.6	43
44	12	Deep	Wabasso fine sand	Medium	Apr-18	19	293	8.1	6.36	3.47	24.35	-18	6.7	44
45	2	Shallow	Matlabar - Pineda Complex	High	Nov-17	486	3434	3.42	3.17	34.01	575.73	-485	7.3	45
46	2	Medium	Matlabar - Pineda Complex	High	Nov-17	37	901	1.85	2.72	5.83	51.41	-37	7	46
47	2	Deep	Matlabar - Pineda Complex	High	Nov-17	81	661	3.78	4.23	9.52	28.62	-80	7.4	47
48	1	Shallow	Myakka fine sand	Low	Sep-13	338	1403	2.33	1.8	14.41	314.6	-338	5.9	48
49	1	Medium	Myakka fine sand	Low	Sep-13	66	558	1.43	1.03	4.86	9.07	-66	6.3	49
50	1	Deep	Myakka fine sand	Low	Sep-13	35	263	1.43	0.91	2.26	29.39	-35	6	50

PASTURE	SOIL TYPE	LEVEL OF BIOSOLIDS APPLICATION	MOST RECENT APPLICATION	SOIL PHOSPHORUS INDEX
1	Myakka fine sand	Low	Sep-13	-438
2	Malabar - Pineda Complex	High	Nov-17	-602
11	Myakka fine sand	High	Apr-18	-432
11	Wabasso fine sand	High	Apr-18	-468
12	Riviera find sand	Medium	Apr-18	-186
12	Wabasso fine sand	Medium	Apr-18	-131
15	Riviera sand	High	Sep-19	-234
15	Pineda sand	High	Sep-19	-626
27	Floridana sand	Medium	Jan-18	-27
27	Riviera sand	Medium	Jan-18	-64
33	Wabasso fine sand	Medium	Dec-17	-200
33	Riviera sand	Medium	Dec-17	-191
36	Wabasso fine sand	Low	Nov-18	-332
42	Riviera sand	Low	Feb-19	-59
37A	Myakka fine sand	High	Nov-19	-94
37A	Immokalee fine sand	High	Nov-19	-89
Timberland	Control 1	None	-	6
Timberland	Control 2	None	-	-2