November 18, 2024

Robert A. Willig
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Office of the Attorney General
1251 Waterfront Place
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Re: ACRE Complaint – Plainfield Township Sewage Sludge Land Application Ordinance

Dear Mr. Willig,

On behalf of the Township of Plainfield, we write in response to your letter regarding a complaint submitted by the [redacted] under the Agriculture, Communities and Rural Environment Act ("ACRE"), which concerns the Plainfield Township Sewage Sludge Land Application Ordinance. *See* Plainfield, Pa., Ordinance 419 (2024) ("Sludge Ordinance"). We appreciate the opportunity to respond to Nazareth's complaint.

The Sludge Ordinance aims to protect Plainfield's citizens, natural resources, and economic wellbeing against harm from per- and polyfluoroalkyl substances ("PFAS"), a class of long-lasting and toxic chemicals that are pervasive in sewage sludge, a residual byproduct of wastewater treatment. An established and growing body of evidence shows that PFAS in sewage sludge cause serious health harms; contaminate soil, plants, air, and water; and render land unsuitable for agriculture. Plainfield adopted the Sludge Ordinance in response to plans by [redacted] a neighboring municipal authority, to dispose of sewage sludge on farmland in Plainfield. In the development of the ordinance, Plainfield's Board of Supervisors considered nearly 50 studies and reports detailing harms from PFAS and consulted with an environmental toxicologist with expertise in PFAS fate and transport.

For the reasons below, [redacted] cannot establish that the Sludge Ordinance is unlawful. The Office of Attorney General must interpret ACRE and all other Pennsylvania laws consistently with Article I, Section 27 of the Constitution of Pennsylvania, also known as the Environmental Rights Amendment ("ERA"), which requires municipalities, as trustees, to protect natural resources for the benefit of the people and prohibits the state from removing municipalities' authority to carry out that obligation. Under a proper interpretation of ACRE, Plainfield's ordinance is lawful. As an initial matter, the ordinance concerns land application of sewage sludge, which—far from being a normal agricultural operation—in fact *contaminates* agricultural land with toxic PFAS. And even if the ordinance did limit a normal agricultural operation, Plainfield has express authority to adopt ordinances that maintain the health and welfare of the Township's citizens and protect against the degradation of its natural resources, as is the case for the Sludge Ordinance. No state law prohibits or preempts the Sludge Ordinance. Accordingly, the Sludge Ordinance is not unlawful, and the Office of Attorney General must deny [redacted] complaint.

FACTUAL BACKGROUND

An established and growing body of evidence demonstrates that PFAS cause serious health harms; contaminate soil, plants, air, and water; and render land unsuitable for agriculture.[1] PFAS are human-made substances used in a wide range of products, such as paper and cardboard packaging, carpet, cookware, clothing, and firefighting foam.[2] Aptly called "forever chemicals," PFAS can persist for decades in the human body[3] and environment.[4] Because PFAS are so long-lasting, multiple exposures can cause PFAS levels to accumulate over time.[5] Exposure to PFAS has been linked to many serious health harms, including testicular and kidney cancer, decreased immune response, pregnancy-induced hypertension/pre-eclampsia, and decreased birth weight.[6] According to the U.S. Environmental Protection Agency ("EPA"), there is no safe level of PFAS for humans.[7]

Numerous studies show that PFAS are frequently found in sewage sludge.[8] Despite the presence of these toxic chemicals, wastewater treatment facilities commonly contract with landowners to dispose of sludge on agricultural lands.[9] After sewage sludge is land applied, PFAS in the sludge enter the soil and are taken up by crops grown on the land.[10] PFAS can also become airborne,[11] leach into groundwater, and run off into surface water, contaminating drinking water supplies.[12] Livestock, fish, and wildlife that come into contact with PFAS in soil,

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[1] *See, e.g.*, Sludge Ordinance, Ex. A; Steven J. Lasse, Lasse Research and Consulting, *Technical Report – Calculation of Consumptive Risk of Soil PFAS from the Land Application of Biosolids* (2024), attached as Exhibit 1.

[2] U.S. Dep't of Health & Hum. Servs., Agency for Toxic Substances & Disease Registry, *Toxicological Profile for Perfluoroalkyls* 2 (2021), https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf.

[3] *See id.* at 5 tbl. 1.1.

[4] *See* Mark L. Brusseau et al., *PFAS Concentrations in Soils: Background Levels Versus Contaminated Sites*, 740 Sci. Total Env't 1, 6 (2020).

[5] *See* Juliane B. Brown et al., *Assessing Human Health Risks from Per- and Polyfluoroalkyl Substance (PFAS)-Impacted Vegetable Consumption: A Tiered Modeling Approach*, 54 Env't Sci. & Tech. 15202, 15202 (2020).

[6] U.S. Dep't of Health & Hum, Servs., *supra* note 2, at 6.

[7] Hiroko Tabuchi, *Something's Poisoning America's Land. Farmers Fear 'Forever' Chemicals*, N.Y. Times (Aug. 31, 2024), https://www.nytimes.com/2024/08/31/climate/pfas-fertilizer-sludge-farm.html.

[8] *See, e.g.*, Ali Behnami et al., *Biosolids, an Important Route for Transporting Poly- and Perfluoroalkyl Substances from Wastewater Treatment Plants into the Environment: A Systematic Review*, 925 Sci. Total Env't 1, 1 (2024).

[9] *See* Hiroko Tabuchi, *5 Takeaways from Our Reporting on Toxic Sludge Fertilizer*, N.Y. Times (Aug. 31, 2024), https://www.nytimes.com/2024/08/31/climate/takeaways-pfas-sludge-fertilizer.html.

[10] *See* M. Christina Schilling Costello & Linda S. Lee, *Sources, Fate, and Plant Uptake in Agricultural Systems of Per- and Polyfluoroalkyl Substances*, 10 Current Pollution Reps. 799, 803, 805–11 (2024).

[11] *See* Annesh Borthakur et al., *Inhalation Risks of Wind-Blown Dust from Biosolid-Applied Agricultural Lands: Are They Enriched with Microplastics and PFAS?*, 25 Current Op. Env't Sci. & Health 1, 1 (2022).

[12] *See* Andrew B. Lindstrom et al., *Application of WWTP Biosolids and Resulting Perfluorinated Compound Contamination of Surface and Well Water in Decatur, Alabama, USA*, 45 Env't Sci. & Tech. 8015, 8020 (2011).

crops, air, and water can then become contaminated.[13] Eating contaminated plants and animals and drinking contaminated water are the primary sources of human exposure to PFAS.[14] One study estimated that eating a single radish grown in soil with elevated PFAS levels could mean surpassing EPA's daily exposure guidelines.[15]

Across the country, land application of sewage sludge has resulted in PFAS contamination that has rendered land unsuitable for agriculture. For example, in Michigan, officials shut down a farm where tests found high concentrations of PFAS in the soil and cattle that grazed on the land.[16] The state later permanently prohibited the property from being used for agriculture.[17] In Texas, owners of a farm where a stillborn calf was found to have high levels of PFAS in its liver stopped sending all of their cattle to market.[18] And in Maine, at least 68 farms were found to have PFAS contamination in their soil, wells, or livestock,[19] which drove at least four farms out of business.[20] The number of contaminated farms in Maine likely is an undercount, as the state has not completed testing.[21] In response to the widespread PFAS contamination, Maine banned sewage sludge application on agricultural land.[22]

Remediating soil and water contaminated with PFAS is difficult and costly. A recent study of methods for removing PFAS from soil explained that "[t]here are currently no proven technologies that can degrade PFAS in soil and sediments in a cost-effective, environmentally-friendly, and energy-efficient manner."[23] A similar study concluded that existing methods for removing PFAS from soil are "expensive, impractical for *in situ* treatment, [and] use high pressures and temperatures, with most resulting in toxic waste."[24] Removing PFAS from drinking water is possible but comes with a significant price tag. For example, the city of Anaheim, California expects to spend $200 million to build a PFAS filtration plant to treat its drinking water.[25] And an owner of a farm in Maine spent $40,000 to install a water filter to

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[13] *See* Clare Death et al., *Per- and Polyfluoroalkyl Substances (PFAS) in Livestock and Game Species: A Review*, 774 Sci. Total Env't 144795, 144795 (2021).
[14] *Id.*
[15] Steven Lasee et al., *The Effects of Soil Organic Carbon Content on Plant Uptake of Soil Perfluoro Alkyl Acids (PFAAs) and the Potential Regulatory Implications*, 40 Env't Toxicology & Chem. 820, 820 (2021).
[16] Tabuchi, *supra* note 7.
[17] *Id.*
[18] *Id.*
[19] *Id.*; *see also* Penelope Overton, *A Forever Farm Is No Match for Forever Chemicals*, Portland Press Herald (June 11, 2023), https://www.pressherald.com/2023/06/11/a-forever-farm-is-no-match-for-forever-chemicals/.
[20] Overton, *supra* note 19.
[21] *See* Me. Dep't of Env't Prot., *PFAS and Maine DEP*, Maine.gov, https://www.maine.gov/dep/spills/topics/pfas/maine-pfas.html (last visited Nov. 14, 2024).
[22] Tabuchi, *supra* note 7.
[23] Jitendra A. Kewalramani et al., *Coupled High and Low-Frequency Ultrasound Remediation of PFAS-Contaminated Soils*, 88 Ultrasonics Sonochemistry 1, 1 (2022).
[24] Esmaeil Shahsavari et al., *Challenges and Current Status of the Biological Treatment of PFAS-Contaminated Soils*, 8 Frontiers Bioengineering & Biotechnology 1, 1 (2021).
[25] Pien Huang, *How a California County Got PFAS out of Its Drinking Water*, NPR (Sept. 12, 2024), https://www.npr.org/sections/shots-health-news/2024/09/12/g-s1-22291/pfas-drinking-water-filter.

control PFAS levels.[26] In 2021, Maine lawmakers created a $60 million fund to help PFAS-impacted farmers.[27] As of June 2023, the state had paid about $2 million to 17 farms to reimburse for lost wages and livestock, testing and filtration, purchasing replacement feed, and changing crops.[28]

EPA and the Pennsylvania Department of Environmental Protection ("DEP") recognize that PFAS in sewage sludge harm human health and natural resources, but the agencies have not yet taken appropriate action to address the harms. In November 2020, EPA held a stakeholder meeting concerning PFAS in biosolids, at which the agency acknowledged that land application of sewage sludge creates multiple pathways for human exposure to PFAS.[29] Similarly, a DEP website explains that sewage sludge land application is one of the primary means of PFAS contamination.[30] EPA and DEP have established contaminant level goals for certain PFAS in drinking water, but federal and state regulations governing sewage sludge land application do not protect against PFAS in sewage sludge.

In 2021, [redacted] purchased an 88-acre farm in Plainfield for the disposal of [redacted] sewage sludge.[31] The farm is preserved under the Northampton County Farmland Preservation Program,[32] which is part of a statewide effort to preserve farmland for agricultural use.[33] In addition to disposing of sewage sludge on the land, [redacted] plans to grow corn and soybeans, which are commonly used for animal feed.[34] Plainfield has appealed DEP's determination that the land is suitable for sewage sludge land application, and the appeal is currently pending before the Environmental Hearing Board. The land abuts homes, is near a community park and the site of the Plainfield Farmers' Fair, and slopes toward a creek.[35] Given the prevalence of PFAS in sewage sludge, [redacted] plan almost certainly will render the land unsuitable for agricultural use, introduce PFAS into the food stream, and contaminate nearby properties and natural resources. As one Plainfield resident who owns a farm near [redacted] and put it, "The [redacted] Authority isn't even located in this town, but they want to bring the sludge and dump it

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[26] Overton, *supra* note 19.
[27] *Id.*
[28] *Id.*
[29] EPA, *EPA Biosolids PFOA & PFOS Problem Formulation Meeting Summary* 14 (2020), https://www.epa.gov/sites/default/files/2021-02/documents/biosolids-pfoa-pfos-meeting-summary-nov-2020.pdf.
[30] DEP, *Pennsylvania's PFAS MCL Rule*, DEP, https://www.dep.pa.gov/Business/Water/BureauSafeDrinkingWater/DrinkingWaterMgmt/Regulations/Pages/PFAS-MCL-Rule.aspx (last visited Nov. 14, 2024).
[31] Tom Venesky, *Residents Fear Polluted Runoff from Municipality's Biosolid Spreading Plan*, Lancaster Farming (Aug. 4, 2023), https://www.lancasterfarming.com/farming-news/conservation/residents-fear-polluted-runoff-from-municipalitys-biosolid-spreading-plan/article_a9fa54d2-313b-11ee-820d-bb123953e8eb.html.
[32] *Id.*
[33] *See* Northampton County, Pa., *Farmland Preservation*, Northampton County https://norcopa.gov/farmland-preservation (last visited Nov. 15, 2024).
[34] *See* Venesky, *supra* note 31.
[35] *Id.*

here. They would never get away with dumping it in their own town, so they bought a farm somewhere else."[36]

LEGAL BACKGROUND

Pennsylvania's Environmental Rights Amendment

Pursuant to the ERA, municipalities must protect their natural resources, and the state cannot eliminate municipalities' authority to carry out that obligation. The ERA provides:

> The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people.

Pa. Const. art. I, § 27. The ERA is written in "broad and flexible terms" that "permit not only reactive but also anticipatory protection of the environment for the benefit of current and future generations." *Pa. Env't Def. Found. v. Commonwealth*, 161 A.3d 911, 919 (Pa. 2017) ("*PEDF II*") (quoting *Robinson Twp. v. Commonwealth*, 83 A.3d 901, 963 (Pa. 2013)).

The first clause of the ERA grants the people environmental rights and "places a limitation on the state's power to act contrary to" those rights, meaning that "any laws that unreasonably impair the right[s] are unconstitutional." *Id.* at 931. The second and third clauses create an environmental trust, which requires the government to "prohibit the degradation, diminution, and depletion of [the] public natural resources,"[37] and to "act affirmatively via legislative action to protect the environment." *Id.* at 933. The ERA's trust duties extend to all levels of government, including municipalities, which have "implicitly necessary authority to carry [those duties] into effect." *Robinson Twp.*, 83 A.3d at 977. As explained below, a plurality of justices of the Supreme Court of Pennsylvania has interpreted the ERA to constrain the General Assembly from removing a municipality's authority to carry out its trust duties, *see id.* at 977–78, and the full Court has adopted the plurality's reasoning, *see PEDF II*, 161 A.3d at 930–33.

The ERA is designed to address the serious harms to public health and natural resources that occurred in the decades leading up to its ratification. *See id.* at 916–18. As one drafter explained, "We polluted our rivers and our streams with acid mine drainage, with industrial waste, with sewage." *Id.* at 918 (quoting *Robinson Twp.*, 83 A.3d at 961). The mounting evidence of PFAS contamination due to sewage sludge land application makes clear that sewage continues to cause problems for the Commonwealth's citizens and natural resources.

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[36] *Id.*

[37] Public natural resources "include[] not only state-owned lands, waterways, and mineral reserves, but also resources that implicate the public interest, such as ambient air, surface and ground water, wild flora, and fauna (including fish) that are outside the scope of purely private property." *Robinson Twp.*, 83 A.3d at 955.

Pennsylvania's Agriculture, Communities and Rural Environment Act

ACRE seeks to ensure "the long-term sustainability of agriculture and normal agricultural operations in a manner that is consistent with State policies and statutes." Act of July 6, 2005, P.L. 112, No. 38. Accordingly, ACRE prohibits local governments from adopting "unauthorized local ordinances." 3 Pa. Cons. Stat. § 313(a) (2005). As relevant here, a local ordinance is unauthorized under ACRE if it "[p]rohibits or limits a normal agricultural operation unless the local government unit: (i) has expressed or implied authority under State law to adopt the ordinance; and (ii) is not prohibited or preempted under State law from adopting the ordinance." *Id.* § 312.

ACRE incorporates the Pennsylvania Right to Farm Act's definition of a "normal agricultural operation," which encompasses "[t]he activities, practices, equipment and procedures that farmers adopt, use or engage in the production and preparation for market of poultry, livestock and their products and in the production, harvesting and preparation for market or use of agricultural, agronomic, horticultural, silvicultural and aquacultural crops and commodities . . . ." 3 Pa. Stat. and Cons. Stat. § 952 (West 1998). "The term includes new activities, practices, equipment and procedures consistent with technological development within the agricultural industry." *Id.* Unlike the Right to Farm Act, ACRE provides that the Attorney General may request the secretary and dean of the College of Agricultural Sciences at The Pennsylvania State University to "provide expert consultation regarding the nature of normal agricultural operations in this Commonwealth." 3 Pa. Cons. Stat. § 314(d) (2005).

While ACRE prohibits unauthorized local ordinances, it does not affect local governments' existing legislative or regulatory authority. To the contrary, ACRE recognizes that "local government units [will] exercise their responsibilities to protect the health, safety and welfare of their citizens in regulating normal agricultural operations." Act of July 6, 2005, P.L. 112, No. 38. And ACRE directs that "nothing in [ACRE] shall be construed to diminish, expand or otherwise affect the legislative or regulatory authority of local government units under State law," including, in particular, local governments' authority under the Nutrient Management Act ("NMA") and their authority over the "regulation, control or permitting procedures for the land application of class A or B biosolids."[38] 3 Pa. Cons. Stat. § 313(c)(2).

Plainfield's Sewage Sludge Land Application Ordinance

Plainfield adopted the Sludge Ordinance to protect the Township's citizens, natural resources, and economic wellbeing against PFAS contamination and related harms resulting from the land application of sewage sludge. *See* Sludge Ordinance § 18-304. To these ends, the ordinance prohibits sewage sludge application in certain especially sensitive areas of the Township, including on land with soils rated by the U.S. Department of Agriculture's Web Soil

[38] Class A and B biosolids are categories of sewage sludge that have been treated to remove or reduce pathogen levels in the sludge. *See* 25 Pa. Code § 271.932 (1997).

Survey as having "very limited" suitability for sewage sludge application,[39] within 1,000 feet of an exceptional value wetland, and within 1,000 feet of a potable water well.[40] *Id.* §§ 18-306(A)(1)–(3). In all other areas, the ordinance permits sewage sludge application so long as the person proposing the application shows that PFAS levels in the sludge do not exceed specified concentrations necessary to limit PFAS contamination in crops grown on the land.[41] *See id.* § 18-306(A)(4). Following a sludge application, the ordinance requires the applicator to obtain soil samples each month for one year to ensure that PFAS levels do not exceed the specified concentrations. *Id.* § 18-306(C)(3). If levels exceed the concentrations, the applicator must notify Plainfield and state agencies and refrain from applying sewage sludge to the same land until PFAS levels fall below the concentrations. *Id.* To promote consistency with state law, the ordinance requires Plainfield to review its concentrations and revise them, if appropriate, should DEP finalize its own sewage sludge concentrations.

The ordinance also requires applicators to inform Plainfield and its citizens of sludge applications. At least 30 days prior to an application, the applicator must submit to the Township the same information that, under existing law, the applicator already must submit to the state. At least 48 hours prior to the application, the applicator must notify the Township of the dates and times of the application and, if the site abuts a public road, post signs warning of the application. And the ordinance allows Plainfield to inspect the application site and obtain soil, water, and sludge samples. In all, the Sludge Ordinance aims to limit health harms from PFAS in sewage sludge, protect local natural resources, and fill gaps in DEP's regulation of sewage sludge land application, until DEP takes appropriate action.

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[39] The U.S. Department of Agriculture considers its Web Soil Survey to be the "single authoritative source of soil survey information." U.S. Dep't of Agric., *Web Soil Survey*, USDA (July 31, 2019), https://websoilsurvey.nrcs.usda.gov/app/. A "very limited" designation means that "the soil has one or more features that are unfavorable for the specified use" and "[p]oor performance and high maintenance can be expected." *Id.* (select "START WSS"; then set Plainfield Township as the "Area of Interest"; then select "Soil Data Explorer"; then select "Suitabilities and Limitations for Use"; then select "Waste Management"; then select "Land Application of Municipal Sewage Sludge"; and then select "View Description" to see "Description – Land Application of Municipal Sewage Sludge"). In addition, "[t]he limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures." *Id.*

[40] The 1,000-foot buffer is based on a study finding PFAS contamination in surface and well water sources located around 1,000 feet from sewage sludge land application sites. *See* Lindstrom et al., *supra* note 12, at 8017 (finding elevated PFAS levels in surface and well water sources located within 500 meters, or 1,640 feet, from sewage sludge land application sites).

[41] The PFAS concentrations are based on PFAS reference doses developed by the Drexel PFAS Advisory Group. *See* Ex. 1, at 7. A reference dose is an estimate of the exposure level below which there is not likely to be an "appreciable risk of deleterious effects." *Id.* The PFAS concentrations reflect the levels of PFAS in soil that could produce plants that have PFAS levels above the PFAS reference doses and, thus, pose a risk of harm to humans, wildlife, and livestock that consume them. *See id.* at 10.

DISCUSSION

The Sludge Ordinance helps protect the Township's citizens and natural resources against contamination from long-lasting and toxic chemicals that are difficult or impossible to clean up. [redacted] asserts with minimal explanation that the ordinance is an unauthorized local ordinance under ACRE because it is preempted by the Solid Waste Management Act ("SWMA"). For the reasons below, Nazareth's assertion fails. The Office of Attorney General must interpret ACRE and Pennsylvania laws governing sewage sludge land application consistently with the ERA. Under that interpretation, the ordinance is consistent not only with the SWMA, but also with the Nutrient Management Act ("NMA") and the Agricultural Area Security Law ("AASL"). Accordingly, the Sludge Ordinance is lawful.

I. ACRE and Pennsylvania laws governing sewage sludge land application must be interpreted consistently with the ERA.

The Office of Attorney General must interpret statutes—including ACRE, the SWMA, the NMA, and the AASL—consistently with the ERA's prohibition on laws that unreasonably impair the environmental rights granted to the people by the ERA. This requirement follows from the General Assembly's obligation to comply with the ERA, *see PEDF II*, 161 A.3d at 930–31, and from the Supreme Court of Pennsylvania's directive to "interpret a statute, where possible, in a way that comports with the constitution's terms," *see Commonwealth v. McClelland*, 233 A.3d 717, 735 (Pa. 2020) (quoting *Commonwealth v. Veon*, 150 A.3d 435, 443 (Pa. 2016)); *see also* 1 Pa. Cons. Stat. § 1922(3) (1972) (codifying the presumption that "the General Assembly does not intend to violate the Constitution of the United States or of [the] Commonwealth"). As discussed below, when all relevant statutes are interpreted consistently with the ERA, Plainfield's ordinance lawfully protects its citizens and natural resources.

II. Plainfield's ordinance is not an unauthorized local ordinance under ACRE.

For the reasons that follow, the Sludge Ordinance is not an "unauthorized local ordinance," as defined under ACRE. 3 Pa. Cons. Stat. § 313(a). First, the ordinance does not limit a normal agricultural operation. Second, even if the ordinance did limit a normal agricultural operation, Plainfield has express authority under the ERA and state law to adopt ordinances that maintain the health and welfare of the Township's citizens and protect against the degradation of its natural resources. And third, the Sludge Ordinance is not prohibited or preempted by state law. Because the ordinance is not an unauthorized local ordinance, the Office of Attorney General must deny [redacted] complaint.

A. Plainfield's ordinance does not limit a normal agricultural operation.

To determine whether a practice constitutes a normal agricultural operation, the Office of Attorney General must make a fact-based assessment that accounts for new evidence. As the Supreme Court of Pennsylvania has explained, ACRE "direct[s] the Attorney General to seek expert opinions regarding what constitute[s] a 'normal agricultural operation' within the meaning of . . . the [Right to Farm Act]; thus, there [is] fact finding inherent in the application of [ACRE]." *Gilbert v. Synagro Cent., LLC*, 131 A.3d 1, 16 (Pa. 2015); *see also Commonwealth v. East Brunswick Twp.*, 956 A.2d 1100, 1115 (Pa. Commw. Ct. 2008) (explaining that ACRE's

instruction to seek expert opinions "suggests, at a minimum, that the determination of what constitutes a 'normal agricultural operation' is an evidentiary, not a legal, determination"). The definition of a normal agricultural operation expressly contemplates new developments in the agricultural industry. *See* 3 Pa. Stat. and Cons. Stat. § 952 ("The term includes new activities, practices, equipment and procedures consistent with technological development within the agricultural industry.").

In addition, the Office of Attorney General must interpret "normal agricultural operation" consistently with ACRE's purposes and with the ERA. *See Binswanger of Pa., Inc. v. TSG Real Est. LLC*, 217 A.3d 256, 262 (Pa. 2019); *Commonwealth v. McClelland*, 233 A.3d at 735. A statutory interpretation must not "lead to an absurdity or make the statute . . . ineffective to accomplish its purpose." *Binswanger of Pa., Inc.*, 217 A.3d at 262 (quoting *Pocono Manor Ass'n v. Allen*, 12 A.2d 32, 35 (Pa. 1940)). Thus, the Attorney General's determination as to whether a practice constitutes a normal agricultural operation must align with ACRE's goals of safeguarding "the long-term sustainability of agriculture and normal agricultural operations" and ensuring that "normal agricultural operations do not negatively impact upon the health, safety and welfare of citizens." Act of July 6, 2005, P.L. 112, No. 38.

Properly understood, land application of sewage is not a normal agricultural operation because, as discussed above, this practice introduces PFAS into the environment, rendering land unsuitable for agriculture, while also causing serious harm to human health and natural resources. The Pennsylvania State University College of Agricultural Sciences has admitted that PFAS "persist through wastewater treatment at levels that may impact the long-term feasibility of 'beneficial reuse of treated wastewater,'" including sewage sludge land application.[42] Across the country, PFAS contamination from sewage sludge land application has forced the closure of multiple farms. Removing PFAS from contaminated soil and water is extremely costly and difficult, if not impossible. In light of this serious harm, deeming sewage sludge land application to be a normal agricultural operation is absurd and directly contrary to the purposes of ACRE, which is meant to safeguard the long-term sustainability of agriculture and ensure that agricultural operations do not harm Pennsylvanians' health, safety, or welfare. *See Binswanger of Pa., Inc.*, 217 A.3d at 262. For the same reason, sewage sludge land application impairs the people's right to "clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment," in violation of the ERA. Pa. Const. art. I, § 27.

[redacted]eliance on *Gilbert v. Synagro Central, LLC* is misplaced. There, the Supreme Court of Pennsylvania held that sewage sludge land application is a normal agricultural activity under the Right to Farm Act. *Gilbert*, 131 A.3d at 18–23. However, the Court expressly did not resolve the question of whether the practice is a normal agricultural operation under ACRE, explaining that under ACRE, the Attorney General must make a fact-based assessment. *See id.* at 16. In addition, the Court rested its decision in *Gilbert*, in part, on the Right to Farm Act's goal of providing a "meaningful degree of legal certainty, uniformity, and consistency" to farms, *id.* at 18, even if their practices constitute a nuisance. The Court reasoned that "[t]his purpose cannot be achieved unless the definition of 'normal agricultural operation' is read

[42] Pa. State Univ., *'Forever Chemicals' Persist Through Wastewater Treatment, May Enter Crops*, PennState (Oct. 26, 2022), https://www.psu.edu/news/research/story/forever-chemicals-persist-through-wastewater-treatment-may-enter-crops.

expansively." *Id.* at 20. But ACRE is meant to ensure the long-term sustainability of agriculture and protect public health, safety, and welfare. To achieve ACRE's ends, therefore, "normal agricultural operation" must be read more narrowly to exclude practices that render land unsuitable for agriculture or that harm public health or welfare. *See Binswanger of Pa., Inc.*, 217 A.3d at 262 (requiring that an interpretation of a statute "effectuate the reasonable result [the statute] intended" (quoting *Pocono Manor Ass'n*, 12 A.2d at 35)). What is more, the *Gilbert* Court necessarily considered only information available at the time, *see id.* at 21–22, but new evidence now shows that the land application of sewage sludge poses serious harm. Although DEP has recognized that harm, it has failed to take appropriate action.

B. Plainfield has express authority under state law and the ERA to adopt the ordinance.

[redacted] does not challenge Plainfield's authority to adopt the Sludge Ordinance. Nor could it, as Plainfield has authority under both the Second Class Township Code and the ERA. Under the Second Class Township Code, a township may adopt any ordinance not inconsistent with the Constitution and laws of the Commonwealth, which is necessary either for the "proper management, care, and control of the township" or for the "maintenance of . . . the health and welfare of the township and its citizens . . . ." 53 Pa. Stat. and Cons. Stat. § 66506 (West 1995). And, as discussed above, under the ERA, municipalities have "implicitly necessary authority to carry into effect" their trust duties. *Robinson Twp.*, 83 A.3d at 977. Indeed, municipalities' authority to effectuate their trust duties is critical to protecting public natural resources. As the Pennsylvania Supreme Court has recognized, "[i]n Pennsylvania, terrain and natural conditions frequently differ throughout a municipality, and from municipality to municipality," such that "the impact on the quality, quantity, and well-being of [the Commonwealth's] natural resources cannot reasonably be assessed on the basis of a statewide average." *Id.* at 979. Instead, "[p]rotection of environmental values . . . is a quintessential local issue that must be tailored to local conditions." *Id.*

The Sludge Ordinance is an exercise of Plainfield's authority to maintain the health and welfare of the Township and its citizens, as well as its authority to carry out its trust duties to "prohibit the degradation, diminution, and depletion of [Plainfield's] public natural resources" and to "act affirmatively via legislative action to protect the environment." *PEDF II*, 161 A.3d at 933. In light of the serious harms caused by PFAS in sewage sludge and DEP's failure to take appropriate action to protect against those harms, the ordinance is necessary for the maintenance of the health and welfare of the Township and its citizens. The ordinance also carries out Plainfield's duties to protect against the degradation of the Township's distinct soil characteristics, endangered species habitat, Exceptional Value Wetlands, and agricultural lands. The ordinance is a limited exercise of Plainfield's authority, as the ordinance does not constitute a complete ban on the land application of sewage sludge, provided certain safety conditions are met, and expressly allows for reconsideration when the state acts. And, as explained below, the ordinance is consistent with state laws governing sewage sludge land application. *See infra* Discussion Section II.C.

C. Plainfield's ordinance is not prohibited or preempted by state law.

As discussed below, interpreting the SWMA, NMA, and AASL to comply with the ERA and Pennsylvania preemption law, as is required, shows that Plainfield's ordinance is not prohibited or preempted. In *Robinson Township v. Commonwealth*, a plurality of justices of the Supreme Court of Pennsylvania held that the ERA prohibits laws that impose statewide ceilings on environmental protections. *See* 83 A.3d at 977–78. There, the Court considered Act 13, which "purport[ed] to preempt the regulatory field to the exclusion of all local environmental legislation," *id.* at 978, and thereby set "statewide 'ceilings' or limits on environmental protections, applicable in every municipality in the Commonwealth, which no local ordinance could exceed, nor deviate from, to address a distinctive local environmental issue of importance to the residents of the municipality," *Robinson Twp. v. Commonwealth*, 147 A.3d 536, 561 (Pa. 2016). The plurality held that Act 13 violated the ERA because it impermissibly stripped local governments of authority to protect public health and the environment, in accordance with their trust duties. *Robinson Twp.*, 83 A.3d at 977–78. The full Court later adopted the plurality's reasoning. *See PEDF II*, 161 A.3d at 930–33.

Pennsylvania preemption law similarly reflects a "reluctance to find that local legislation is preempted by state statutes." *Mars Emergency Med. Servs., Inc. v. Twp. of Adams*, 740 A.2d 193, 195 (Pa. 1999). Pennsylvania recognizes three types of preemption:

> (1) express or explicit preemption, where the statute includes a preemption clause, the language of which specifically bars local authorities from acting on a particular subject matter; (2) conflict preemption, where the local enactment irreconcilably conflicts with or stands as an obstacle to the execution of the full purposes of the statute; and (3) field preemption, where analysis of the entire statute reveals the General Assembly's implicit intent to occupy the field completely and to permit no local enactments.

Hoffman Mining Co. v. Zoning Hearing Bd. of Adams Twp., 32 A.3d 587, 593–94 (Pa. 2011).

Both conflict and field preemption "require an analysis of whether preemption is implied in or implicit from the text of the whole statute." *Id.* at 594. As for conflict preemption, an ordinance does not irreconcilably conflict with a statute unless "simultaneous compliance with both the local ordinance and the state statute is impossible." *Id.* And an ordinance does not present an obstacle to a statute's purposes if the ordinance makes "such additional regulations in aid and furtherance of the purpose of the general law as may seem appropriate to the necessities of the particular locality and which are not in themselves unreasonable." *Id.* at 595 (quoting *Mars Emergency Med. Servs., Inc.*, 740 A.2d at 195). As for field preemption, "the mere fact that the General Assembly has enacted legislation in a field does not lead to the presumption that the state has precluded all local enactments in that field; rather, the General Assembly must clearly evidence its intent to preempt." *Id.* at 593. The Supreme Court of Pennsylvania "has determined that the General Assembly has evidenced a clear intent to totally preempt local regulation in only three areas: alcoholic beverages, anthracite strip mining, and banking." *Id.*

1. The SWMA does not prohibit or preempt the ordinance.

The SWMA may not be interpreted to preempt local ordinances that exceed the protections set out in the statute. Such an interpretation would result in a statewide ceiling on environmental protections against pollution from solid waste and, in turn, would strip local governments of their authority to carry out their constitutionally mandated trust duties and address local environmental conditions, which vary within and between municipalities. *Robinson Township* makes clear that state laws to that effect violate the ERA.[43] *See* 83 A.3d at 977–78. To ensure that the SWMA complies with the ERA, as required, the SWMA must instead be interpreted to allow for local regulation that fulfills a municipality's trust duties and accounts for local environmental conditions—that is, local regulation that protects against the "degradation, diminution, and depletion of [the municipality's] public natural resources," *PEDF II*, 161 A.3d at 933—even if the local regulation exceeds the SWMA's protections. Under that interpretation, the Sludge Ordinance—which is necessary to protect local environmental conditions in the Township, including its distinct soil characteristics, endangered species habitat, Exceptional Value Wetlands, and agricultural lands, from PFAS contamination—is not preempted.

The SWMA's text supports the conclusion that it does not preempt the Sludge Ordinance. First, there is no express preemption, as the SWMA does not include a preemption clause barring local regulation of solid waste. Second, there is no conflict preemption because the ordinance does not irreconcilably conflict with the SWMA or stand as an obstacle to its purposes. The Sludge Ordinance imposes protections that add to those in the SWMA, making it possible to comply with both the ordinance and the SWMA. *See Moyer v. Gudknecht*, 67 A.3d 71, 76 (Pa. Commw. Ct. 2013) (explaining that "the fact that [an] [o]rdinance imposes an additional requirement [as compared with a state statute] does not constitute a conflict" because "[a]dditional requirements beyond those in a state statute are not preempted unless they conflict with a *purpose* of the statutory provisions"). And, in light of the harm that PFAS in sewage sludge cause to human health and natural resources, the protections in the ordinance advance the SWMA's goals of "protect[ing] the public health, safety, and welfare from the short and long term dangers of . . . disposal of all wastes" and "implement[ing] Article I, section 27 of the Pennsylvania Constitution." 35 Pa. Stat. and Cons. Stat. §§ 6018.102(4), (10) (West 1980).

Third, there is no field preemption because, far from forbidding local involvement in solid waste regulation, the SWMA reveals the General Assembly's clear intent to encourage state and local coordination and cooperation. Indeed, in the only Supreme Court of Pennsylvania case to consider preemption under the SWMA, a plurality of justices agreed that the General Assembly did *not* intend for the SWMA to preempt local regulation of solid waste. *See Hydropress Env't Servs., Inc. v. Twp. of Upper Mount Bethel*, 836 A.2d 912, 918–19 (Pa. 2003).

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[43] Although *Robinson Township* recognized that "the duties to conserve and maintain are tempered by legitimate development tending to improve upon the lot of Pennsylvania's citizenry, with the evident goal of promoting sustainable development," 83 A.3d at 958, sewage sludge land application does not constitute such development. Far from improving upon the welfare of Pennsylvania's citizenry and promoting sustainable development, sewage sludge application in fact harms the health, safety, and welfare of Pennsylvania's citizens; renders land unsuitable for agriculture; and contaminates the state's natural resources. *See supra* Factual Background.

In support, the plurality emphasized that the "primary legislative statement of the purposes of the SWMA" is to "establish and maintain a *cooperative State and local program* . . . ." *Id.* (quoting 35 Pa. Stat. and Cons. Stat. § 6018.102(1) (emphasis added)). In addition to the statement of purposes, the plurality identified numerous other provisions in the SWMA that reflect dual roles for state and local governments:

> [DEP's] delegated duties include cooperation with local units of government, and the training of local municipal personnel. County health departments are expressly delegated powers of administration and enforcement. Local municipalities are expressly charged with planning responsibilities, as well as permit review and comment functions. Finally, municipal solicitors are expressly authorized to commence actions at law and in equity to restrain violations of the SWMA, and it is "declared to be the purposes of [the Act] to provide additional and cumulative remedies . . . ."

Id. at 919 (internal citations omitted). Thus, the plurality concluded, the SWMA's language is that "of intergovernmental coordination and cooperation, not of preemption." *Id.*

Finally, ACRE's express acknowledgment that nothing in ACRE "affect[s] the legislative or regulatory authority of local government units" over the "regulation, control or permitting procedures for the land application of class A or B biosolids," 3 Pa. Cons. Stat. § 313(c)(2), bolsters the conclusion that the General Assembly did not intend for the SWMA to preempt the field of solid waste regulation. If the SWMA preempted the field, it would make no sense to acknowledge local governments' authority to regulate and control land application of biosolids.

The few Commonwealth Court cases on which [redacted]elies do not support its position that the SWMA preempts the Sludge Ordinance. First, the cases predate the Supreme Court of Pennsylvania's decision in *Robinson Township* and, thus, fail to grapple with the ERA's prohibition on state laws that impose statewide ceilings on environmental protections, as articulated in *Robinson Township*. To the contrary, [redacted]cites cases that interpret the SWMA to impose a statewide ceiling, in direct conflict with *Robinson Township*. *See, e.g.*, *Liverpool Twp. v. Stephens*, 900 A.2d 1030, 1036 (Pa. Commw. Ct. 2006) (holding that the SWMA preempts local ordinances that regulate "how, when and where sewage waste may be used to fertilize farmland"); *Commonwealth v. E. Brunswick Twp.*, 980 A.2d 720, 733 (Pa. Commw. Ct. 2009) (holding that the SWMA preempts local ordinances that "duplicate the regulatory regime established in the SWMA" or "impose more stringent requirements than the SWMA"). Second, none of the cases involved a local ordinance like Plainfield's Sludge Ordinance, which is targeted at harm from PFAS in sewage sludge, tailored to local environmental conditions, and limited to filling a gap in DEP's regulation of sewage sludge land application until DEP takes appropriate action. And third, even if the cases were applicable, [redacted]does not explain how their reasoning would preempt Plainfield's Sludge Ordinance in its entirety. Many of the ordinance's provisions do not govern how, when, or where sludge may

be applied, so they are not preempted even under [redacted] incorrect reading of the law.[44]

2. The NMA does not prohibit or preempt the ordinance.

Like the SWMA, the NMA may not be interpreted to preempt local ordinances that exceed the protections set out in the statute, as that interpretation would create a statewide ceiling on environmental protections and thereby strip local governments of their authority to carry out their trust duties and address local environmental conditions, in violation of the ERA. *See Robinson Twp.*, 83 A.3d at 977–78. To ensure that the NMA complies with the ERA, as is required, the statute's express preemption clauses must be interpreted to permit local regulation in furtherance of a municipality's trust duties, even if the local regulation exceeds the protections in the NMA. The NMA's express preemption clauses provide:

> This chapter and its provisions are of Statewide concern and occupy the whole field of regulation regarding nutrient management and odor management, to the exclusion of all local regulations. . . . No ordinance or regulation of any political subdivision or home rule municipality may prohibit or in any way regulate practices related to the storage, handling or land application of animal manure or nutrients or to the construction, location or operation of facilities used for storage of animal manure or nutrients or practices otherwise regulated by this chapter if the municipal ordinance or regulation is in conflict with this chapter and the regulations or guidelines promulgated under it. . . . Nothing in this chapter shall prevent a political subdivision or home rule municipality from adopting and enforcing ordinances or regulations which are consistent with and no more stringent than the requirements of this chapter and the regulations or guidelines promulgated under this chapter.

3 Pa. Cons. Stat. §§ 519(a), (b), (d) (2005). As explained below, the NMA's preemption clauses do not prohibit local regulation of land application of nutrients, which the NMA defines to include sewage sludge. *Id.* § 503.

The Supreme Court of Pennsylvania has interpreted the NMA's preemption clauses, but because the parties did not raise the ERA, the Court did not consider its prohibition on statewide ceilings on environmental protections. *See Berner v. Montour Twp. Zoning Hearing Bd.*, 217 A.3d 238 (Pa. 2019). The Court held:

> Taken together, the [NMA's express preemption clauses] do not evidence an intent on behalf of the Legislature to preclude all local regulation in the field of nutrient management. Instead, viewed in its entirety, [the NMA] reveals the Legislature's intent to prohibit local regulation of nutrient management only to the extent that it

[44] These provisions include requirements to submit information to Plainfield prior to an application; notify Plainfield of an application 48 hours in advance; obtain soil samples after an application and notify Plainfield and state agencies if PFAS concentrations exceed those in the ordinance; allow a Plainfield agent to inspect land before an application and obtain soil and water samples; and allow a Plainfield agent to inspect land during an application and obtain sewage sludge samples. Pursuant to the ordinance's severability clause, even if other provisions in the ordinance are preempted, these provisions would stand. Sludge Ordinance § 18-311.

> is more stringent than, inconsistent with, or in conflict with the Act or its regulations.

Id. at 248. Because the Court did not account for the ERA, its decision does not resolve whether, consistent with the ERA, the NMA preempts Plainfield's ordinance.

Interpreting the NMA to comply with the ERA, the NMA does not preempt the Sludge Ordinance. As the Court concluded, the NMA does not preclude all local regulation in the field of nutrient management. *See id.* While the NMA may preempt local regulation to the extent that it is inconsistent or in conflict with the NMA, as such preemption does not set a statewide ceiling on environmental protections, it may not preempt local regulation to the extent that it is more stringent than the NMA, because such preemption sets an impermissible statewide ceiling. ACRE's acknowledgement that nothing in ACRE affects local governments' legislative or regulatory authority under the NMA, 3 Pa. Cons. Stat. § 313(c)(1), confirms this reading, as the acknowledgement would be unnecessary if the NMA preempted all local regulation under the NMA.

Applying the interpretation that the ERA requires, the Sludge Ordinance is not inconsistent or in conflict with the NMA and, thus, is not preempted. The Sludge Ordinance does not contain any restrictions related to nitrogen and phosphorus in sewage sludge, which is the focus of the NMA. *See* 25 Pa. Code § 83.291(a) (2006) ("Nitrogen and phosphorus are the only nutrient elements of concern to be addressed by [best management practices] in the [nutrient management] plan."). Instead, the ordinance imposes PFAS-related protections that add to the nutrient-related protections in the NMA, making it possible to comply with both the ordinance and the statute. And, given the harm that PFAS in sewage sludge cause to agriculture and natural resources, the protections in the ordinance advance, rather than conflict with, the NMA's goal of "improv[ing] farm efficiency and prevent[ing] the . . . pollution of surface water and groundwater from agricultural nutrients." 27 Pa. Bull. 3161 (June 28, 1997).

3. The AASL does not prohibit or preempt the ordinance.

Finally, the AASL does not prohibit or preempt the Sludge Ordinance. The AASL includes a preemption clause that provides:

> Every municipality or political subdivision within which an agricultural security area is created shall encourage the continuity, development and viability of agriculture within such an area by not enacting local laws or ordinances which would unreasonably restrict farm structures or farm practices within the area in contravention of the purposes of this act unless such restrictions or regulations bear a direct relationship to the public health or safety.

3 Pa. Stat. and Cons. Stat. § 911(a) (West 1988).[45] As explained below, Plainfield's ordinance does not fall within the preemption clause, as it does not restrict a farm practice, and even if it did, it imposes reasonable restrictions that do not contravene the AASL's purposes and directly relate to public health and safety.

First, the Sludge Ordinance does not restrict a farm practice. To Plainfield's knowledge, neither the AASL nor Pennsylvania caselaw defines "farm practices." However, interpreting the term in line with the AASL's purposes, as is required, *see Binswanger of Pa., Inc.*, 217 A.3d at 262, demonstrates that sewage sludge land application is not a farm practice. The AASL aims to "conserve and protect and to encourage the development and improvement of its agricultural lands for the production of food and other agricultural products" and to "conserve and protect agricultural lands as valued natural and ecological resources which provide needed open spaces for clean air, as well as for aesthetic purposes." 3 Pa. Stat. and Cons. Stat. § 902 (West 1988). Sewage sludge land application is an impediment to those purposes, as it renders land unsuitable for the production of food for humans or animals, threatens human health, and contaminates the Commonwealth's natural resources. Deeming sewage sludge land application to be a farm practice, and thereby making it more difficult for local governments to enact ordinances that protect against harms from the practice, would run directly counter to the AASL's purposes.

Second, even if the Sludge Ordinance did restrict a farm practice, it imposes reasonable restrictions that do not contravene the AASL's purposes and directly relate to public health and safety. The ordinance's restrictions are reasonable in light of their targeted focus on harm from PFAS in sewage sludge, their link to local environmental conditions, and their limited duration, which expressly allows for reconsideration when the state takes appropriate action to protect against harm from PFAS. The ordinance's restrictions also advance the AASL's purpose, as they help prevent PFAS contamination of agricultural lands, human and animal food, and air and water. And, in light of the established and growing body of evidence linking PFAS exposure to serious health harms, the restrictions directly relate to public health and safety.

CONCLUSION

PFAS in sewage sludge cause serious health harms; contaminate soil, plants, air, and water; and render land unsuitable for agriculture. DEP recognizes that land application of sewage sludge is a primary driver of PFAS contamination, but it has not yet acted to prevent contamination from occurring. [redacted] plan to dispose of its sewage sludge on farmland in Plainfield will leave Plainfield saddled with the dangerous and costly consequences of PFAS contamination. The Sludge Ordinance imposes tailored and limited restrictions that are necessary to protect Plainfield's citizens and natural resources until DEP acts. In an attempt to challenge the ordinance and carry out its plan to dispose of its sludge in Plainfield [redacted] relies on statutes aimed at protecting public health, preventing pollution, and supporting agriculture. But sewage sludge land application in fact undermines those goals. For the reasons above, the Office of Attorney General must deny [redacted] complaint.

[45] Plainfield is home to an agricultural security area, so it is subject to the AASL. *See* Tom Wolf & Russell Redding, Pa. Dep't of Agric., *Commonwealth of Pennsylvania Agricultural Security Area Handbook* 18 (2016).

Sincerely,

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Exhibit 1

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TECHNICAL REPORT – Calculation of Consumptive Risk of Soil PFAS from the Land Application of Biosolids

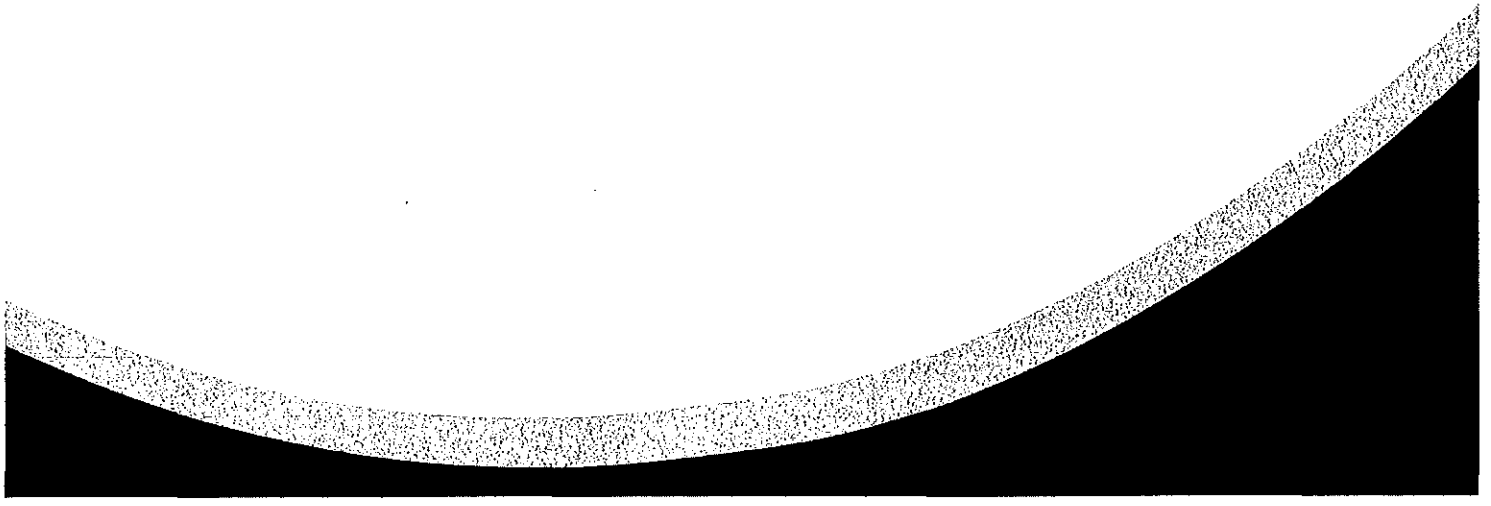
At the request of: Plainfield Township

Developed by: Steven J. Lasee MS PhD, Lasee Research and Consulting

Section 1- Introduction

a. Document Summary

Plainfield Township, Pennsylvania requested assistance determining regulatory levels for PFAS in agricultural plots slated for the land application of biosolids and/or sewage sludge. Exposure scenarios were explored, and it was determined that a pertinent exposure route was through plant uptake of PFAS from soil, accumulation in their tissues, and subsequent consumption by people and animals. Reference doses developed by the Drexel PFAS Advisory Group for the Pennsylvania Department of Environmental Protection were used to calculate exposure breakpoints for PFOS, PFOA, PFHxS, PFBS, PFNA, and HFPO-DA. Models published by this report's author for plant uptake of soil PFAS were then used to calculate exposure potentials and "Consumptive risk soil levels" were developed.



The "Consumptive risk soil levels" derived in this report.

"Consumptive Risk Soil Level" That Can Reach TDI Through Plant Consumption (ng/g, ppb)

SHOOT	50 kg adult female	upper CI	70 kg adult	upper CI	100 kg adult male	upper CI
PFOA	2.9	0.6	4.0	0.8	5.7	1.2
PFOS	2.6	1.0	3.6	1.5	5.2	2.1
PFNA	2.0	0.4	2.8	0.6	3.9	0.9
PFHXS	1.0	0.5	1.5	0.7	2.1	1.0
PFHPA						
PFBS	5.4	1.8	7.6	2.5	10.8	3.6
HFPO-DA	21.8	11.0	30.5	15.4	43.6	22.1
ROOT	50 kg adult female	upper CI	70 kg adult	upper CI	100 kg adult male	upper CI
PFOA	2.2	1.1	3.1	1.6	4.4	2.2
PFOS	1.8	1.4	2.5	1.9	3.5	2.8
PFNA	2.0	1.0	2.8	1.4	3.9	2.0
PFHXS	3.3	1.3	4.7	1.8	6.7	2.6
PFHPA						
PFBS	27.1	3.3	37.9	4.6	54.2	6.6
HFPO-DA	55.1	26.8	77.2	37.5	110.3	53.6

Contents

b. Abbreviations and Terms

PFAS - Per- and polyfluoroalkyl substances

PFOS - Perfluorooctanesulfonic acid

PFOA - Perfluorooctanoic acid

PFHxS - Perfluorohexanesulfonic acid

PFBS - Perfluorobutanesulfonic acid

PFNA - Perfluorononanoic acid

HFPO-DA - hexafluoropropylene oxide dimer acid, also colloquially known as GenX

USEPA - United States Environmental Protection Agency

ppm, ppb, ppt – parts per million, billion, and trillion

DPAG - Drexel PFAS Advisory Group

RfD - Reference dose

MCL - Maximum contaminant levels

MCLG - Maximum contaminant level goals

TDI - Tolerable Daily Intakes

BCF - Bioconcentrations factors

MSC - Medium-specific concentration

RSL - Regional Screening Levels

CRSL - Consumptive Risk Soil Level

****The terms "Biosolids", "sewage sludge", and any other waste treatment facility derived products can be used interchangeably in this document. There are classification differences between these terms, but for their application in this technical report they are interchangeable.

c. Relevant Background Information

- Biosolids, sewage sludge, and other waste treatment facility derived products are well-known sources of multiple PFAS and a source of environmental contamination around the world [1–7].
- The concentrations of legacy PFAS in biosolids (like PFOS) have also remained stable since their phase out. The mean load of ∑PFASs in U.S. biosolids was estimated at 2749–3450 kg/year, of which about 1375–2070 kg is applied on agricultural land and 467–587 kg goes to landfills as an alternative disposal route [8].
- A meta-analysis study on effluent from US waste treatment facilities determined the national mean PFOA concentration was 8.4 ± 0.4 ng/L in data collected from 2013 to 2020 with outliers omitted, indicating persisting low-level occurrence. This would equate to 383 ± 20 kg of PFOA per year continuing to enter the environment via waste treatment faculties effluent [9].
- It is well established that PFAS from biosolids applied to agricultural plots are available for uptake and accumulation by plants [10–15].
- Consumption of forage and fodder grown in PFAS contaminated soils has been shown to result in PFAS accumulation in wildlife and livestock [16–21]. Consumption of these animals will then result in PFAS exposure to humans.
- An Australian study discovered using the population data supplied by the participating wastewater treatment plants, the mean annual estimated biosolids-associated PFAS contribution is 6 mg per person per year and ranged between 0.6 mg and 15 mg [22]. The Australian waste treatment system is similar to is counterpart in the United States, so these results are relevant to the United States.
- A study describing a situation in Decatur, Alabama where PFAS contaminated biosolids from a local municipal wastewater treatment facility were used as a soil amendment in local agricultural fields for as many as twelve years. Results show that surface and well water in the vicinity of these fields had elevated PFC concentrations, with 22% of the samples exceeding the U.S. Environmental Protection Agency's Provisional Health Advisory level for PFOA in drinking water of 400 ng/L [23]. The highest concentration they observed was 31,906 ng/L and the current USEPA Maximum Concentration Level (MCL) is 4 ng/L for PFOA and PFOS. Many other studies have noted PFAS runoff in waterbodies from biosolid application to agricultural fields [24–31]. Ultimately, any PFAS entering bodies of water are expected to accumulate in their fish and will result in an exposure to PFAS to anyone consuming those fish. Several states, including Pennsylvania, have "do no eat" advisories for fish related to PFAS contamination of bodies of water.

- Many PFAS are incredibly resistant to environmental degradation and are largely considered to exist in the environment essentially indefinitely. Therefore, any contamination has a strong potential to accumulate and soil concentrations are expected to be permanent [32]. Therefore, any risk associated with PFAS contamination of soil (contaminated vegetation, run-off, groundwater contamination, etc.) will also persist for decades.
- Studies have found prior USEPA drinking water regulations to not be protective of vegetable exposures to PFAS[24] (USEPA regulations are much lower now, 70 ppt to 4 ppt for PFOS and PFOA). Water to crop transfer has been indicated as an important exposure pathway for communities with PFAS-impacted irrigation water[25]. This is also true for agricultural plots impacted by PFAS-laden biosolids [35].
- A study on precursor and so-called "unknown" PFAS found for all tested biosolids greater than 75% of the PFAS fluorine mass was associated with precursors [36]. These precursors and "unknown" PFAS have poorly understood or unknown toxicity and potentially will convert to PFAS of concern (like PFOS, PFOA, and PFHxS) [37] and will remain in the soil for decades [38].
- Studies simulating PFOS surface contamination illustrate it can take several decades or longer for PFOS to reach groundwater [39]. Surface PFAS contamination through biosolids application may take decades to show up in peoples' drinking water, but once it does, it will be an issue for generations.

Section 2- Calculating Soil Concentrations That Could Result in Consumptive Risk

a. Reference Doses

Reference doses (RfD) are defined by the United States Environmental Protection Agency as "[A]n estimate, with uncertainty spanning perhaps an order of magnitude, of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime." They are chemical specific and given as an exposure (typically in grams) per kilogram body weight per day. Essentially, they are an exposure limit that, if below, no adverse noncancer health effects are expected from a lifetime of exposure.

In January 2021, the Drexel PFAS Advisory Group (DPAG), through a contract with PA's Safe Drinking Water Program, developed RfD for 6 PFAS (PFOA, PFOS, PFNA, PFHxS, PFBS, and HFPO-DA) for the state of Pennsylvania (Table 1). DPAG also developed maximum contaminant level goals (MCLG) for drinking water. MCLGs are non-enforceable public health goals, developed solely based on health effects, and do not take into consideration other factors, such as technical limitations and cost. MCLGs are the starting point for determining maximum contaminant levels (MCL). An MCL is the legal threshold limit on the amount of a substance that is allowed in public water systems under the Safe Drinking Water Act. That being said, the USEPA has stated that no exposure to PFAS should be considered "safe".

Table 1 – Taken from:

https://www.pacodeandbulletin.gov/Display/pabull?file=/secure/pabulletin/data/vol53/53-2/46.html

DPAG Reference Dose and Recommended Chronic Non-Cancer MCLGs		
PFAS	Reference Dose (ng/kg/day)	MCLG (ng/L or ppt)
PFOA	3.9	8
PFOS	3.1	14
PFNA	2.2	6
PFHxS	4.0	20
PFHpA	None derived*	8
PFBS	39	55
GenX (HFPO-DA)	75	108

With DPAG's RfDs, Tolerable Daily Intakes (TDI) can be established by multiplying the RfDs by reference body weights. Table 2 contains the daily exposure limits breakpoints in ng for body sizes of 10 kg, 20 kg, 50 kg, 70 kg, and 100 kg for these 6 PFAS.

Table 2

Calculating Tolerable Daily Intake (TDI) breakpoints off of DPAG RfDs (ng)

PFAS	Reference Dose (ng/kg/day)	10 kg child	20 kg child	50 kg adult	70 kg adult	100 kg adult
PFOA	3.9	39	78	195	273	390
PFOS	3.1	31	62	155	217	310
PFNA	2.2	22	44	110	154	220
PFHxS	4	40	80	200	280	400
PFHpA	None derived*					
PFBS	39	390	780	1950	2730	3900
GenX (HFPO-DA)	75	750	1500	3750	5250	7500

Lasee et al. 2020 developed modeling equations (Figure 1) that estimate PFAS bioconcentrations factors (BCF) in dry plant tissues off of soil organic carbon levels and soil PFAS concentrations[10]. Soil organic carbon is used in these equations as it is the soil trail most strongly correlated with PFAS availability for uptake by plants[11,40–42]. BCFs are a ratio of the concentration in the plant tissue compared to that in the soil (i.e. BCF = tissue concentration/soil concentration). These BCFs can then be multiplied by a measured or simulated soil PFAS concentration to model potential exposure from consuming plants grown in PFAS contaminated soil.

Figure 1 – Lasee et al. 2020's PFAS plant uptake modeling equations.

TABLE 2: Trendline equations, R^2 values, and 95% confidence interval (CI) values for shoot and root tissue perfluoro alkyl acid (PFAA) bioconcentration factors (on the *y*-axis) was a function of soil organic carbon (SOC) percentage (on the *x*-axis)[a]

PFAA		Shoot equation	R^2	95% CI		Root equation	R^2	95% CI
PFBS	Eq. 8	$y = -23.8\ln(x) + 25.5$	0.80	17.9	Eq. 15	$y = -12.3\ln(x) + 10.3$	0.61	12.9
PFHxS	Eq. 9	$y = -6.5\ln(x) + 9.3$	0.44	5.5	Eq. 16	$y = -2.3\ln(x) + 3.1$	0.54	2.3
PFHpA	Eq. 10	$y = -47.2\ln(x) + 32.5$	0.68	33.8	Eq. 17	$y = -16.6\ln(x) + 12.3$	0.88	12.2
PFOA	Eq. 11	$y = -11.9\ln(x) + 9.9$	0.54	6.4	Eq. 18	$y = -3.7\ln(x) + 4.8$	0.54	2.2
PFOS	Eq. 12	$y = -2.7\ln(x) + 3.4$	0.25	2.2	Eq. 19	$y = -0.13\ln(x) + 2.3$	0.01	0.6
PFNA	Eq. 13	$y = -5.5\ln(x) + 5.2$	0.44	4.9	Eq. 20	$y = -1.45\ln(x) + 2.4$	0.50	1.4
All PFAAs	Eq. 14	$y = -14.6\ln(x) + 14.4$	0.27	4.16	Eq. 21	$y = -5.9\ln(x) + 5.8$	0.33	1.75

[a]For abbreviations, see Table 1 footnote.

b. Calculating PFAS Bioconcentration Factors for the Modeled Soil

Soils in Pennsylvania agricultural fields range between 2.4-15.5% organic matter[43]. Typically, half of organic matter will be organic carbon. We will use 2% organic carbon for the model for a more conservative estimate. The average vegetable consumption of an American adult is approximately 1 pound 400 grams a day [43]. Additionally, dried plant tissue typically represents approximately 10% of the mass of their non-dried counterpart.

Then, using equations developed in Lasee et al. 2020 (Figure 1), we can calculate bioconcentration factors for plants grown on the modeled agricultural plot.

Table 3 - Bioconcentration factors (and upper confidence interval) for plants grown in PFAS contaminated soil assuming 2% organic carbon and converting to non-dry plant matter.

Estimated BCF from Lasee et al. 2020 for root and shoot at 2%				
	Shoot	upper CI	Root	upper CI
PFOA	1.7	8.1	2.2	4.4
PFOS	1.5	3.7	2.2	2.8
PFNA	1.4	6.3	1.4	2.8
PFHxS	4.8	10.3	1.5	3.8
PFHpA				
PFBS	9	26.9	1.8	14.7
GenX (HFPO-DA)*	4.3	8.5	1.7	3.5
BCF Converted to wet matter (divided by 10, most plants are 90% water)				
	Shoot	upper CI	Root	upper CI
PFOA	0.17	0.81	0.22	0.44
PFOS	0.15	0.37	0.22	0.28
PFNA	0.14	0.63	0.14	0.28
PFHxS	0.48	1.03	0.15	0.38
PFHpA				
PFBS	0.9	2.69	0.18	1.47
GenX (HFPO-DA)*	0.43	0.85	0.17	0.35

* used general PFAS equation

c. Calculating PFAS Soil Concentration that can Surpass DPAG's RfD

With these modeled BCFs we can calculate the soil PFAS concentrations that could produce vegetables that surpass the DPAG's RfD. This is done by taking the Tolerable Daily Intakes (TDI, were derived from the DPAG RfD) from Table 2 and dividing it by 400 grams, to get a vegetable concentration that a 400 gram daily consumption of would result in surpassing the TDI for each individual PFAS. This value is then divided by the BCF and upper confidence interval converted to wet matter values from Tabe 3 to get a soil concentration. These soil concentrations are deemed the "Consumptive risk soil level" (CRSL) (Table 4).

Table 4

"Consumptive Risk Soil Level" That Can Reach TDI Through Plant Consumption (ng/g, ppb)

SHOOT	50 kg adult female	upper CI	70 kg adult	upper CI	100 kg adult male	upper CI
PFOA	2.9	0.6	4.0	0.8	5.7	1.2
PFOS	2.6	1.0	3.6	1.5	5.2	2.1
PFNA	2.0	0.4	2.8	0.6	3.9	0.9
PFHXS	1.0	0.5	1.5	0.7	2.1	1.0
PFHPA						
PFBS	5.4	1.8	7.6	2.5	10.8	3.6
HFPO-DA	21.8	11.0	30.5	15.4	43.6	22.1
ROOT	50 kg adult female	upper CI	70 kg adult	upper CI	100 kg adult male	upper CI
PFOA	2.2	1.1	3.1	1.6	4.4	2.2
PFOS	1.8	1.4	2.5	1.9	3.5	2.8
PFNA	2.0	1.0	2.8	1.4	3.9	2.0
PFHXS	3.3	1.3	4.7	1.8	6.7	2.6
PFHPA						
PFBS	27.1	3.3	37.9	4.6	54.2	6.6
HFPO-DA	55.1	26.8	77.2	37.5	110.3	53.6

These equations do not address PFAS accumulation in wildlife and livestock and the associated risk of PFAS exposure from consuming these animals or the health of these animals. For context, beef cattle and white-tail deer can consume as much as 15 kg and 6 kg of forage a day, which is 37.5 and 15 times a human's daily consumption of plant material. Consumption of contaminated plant material and feed produced with contaminated plant material is thus an important exposure route for these animals, and studies have shown a strong potential for accumulation of PFAS in the edible tissues of sheep, cows, and chickens from naturally contaminated feed (through plant uptake from PFAS contaminated soil) [17–19].

News reports of culling livestock and farm shutdowns due to PFAS contamination from biosolids are becoming increasingly common around the US [44–47]. Additionally, several states including Wisconsin, Maine, New Hampshire, and Michigan have given "do not eat" warning for deer and other game due to high PFAS levels in their tissues.

d. Sampling guidelines

The USEPA has developed a method for sampling both soil and biosolids for PFAS concentration: Method 1633 Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS. Pennsylvania's Department of Environmental Protection has an accreditation program for analytical laboratories for running this method. Method 1633 has guidelines for sampling soil and biosolids.

Given that PFAS are known to distribute heterogeneously in biosolids and soils, multiple copies of the samples should be collected to assure the quality of the analysis. Triplicates sampling is the standard used in PFAS work for a single media (i.e. the biosolids or sewage sludge pre application). For sampling a field, multiple samples should be taken throughout the field. Something like a flat square field should have the four corners and the middle of the field sampled. If there is a drainage area of the field, that area should be sampled as well. Surface soil sampling is appropriate, as the biosolids are applied to the surface.

75% of PFAS in biosolids are precursors/"unknown" PFAS. Overtime, some of these PFAS will convert to "known" PFAS and give the appearance of increasing PFAS concentrations overtime. Sampling should be done monthly to identify this phenomenon and mitigate the potential for soil concentrations surpassing the CRSL as time goes on.

Section 3 - Comparing Values to Current Guidelines

a. Pennsylvania Guidelines

In May 2024, the United States Environmental Protection Agency updated their Regional Screening Levels (RSL) for many chemicals, including many PFAS (Tables 6, S3, and S4). This update reflected their recent creation of drinking water standards for PFOS, PFOA, PFBS, PFHxS, PFNA, and HFPO-DA. These new PFAS standards were more stringent than similar guidance that existed prior.

Pennsylvania has soil and soil-to-groundwater screening levels (Tables 5, S1, and S2) for PFOS, PFOA, and PFBS. On June 25th, 2024, Pennsylvania adopted the USEPA's Maximum Concentration Levels (MCL) for their statewide health standard medium-specific concentration (MSC) values for groundwater (figure 3). Given that Pennsylvania adopted the USEPA's updated guidelines for groundwater and that Pennsylvania's soil and soil-to-groundwater screening levels have not yet received a similar update. It's fair to say Pennsylvania's soil and soil-to-groundwater screening levels will eventually receive an update with the USEPA's equivalent values and may currently be outdated. As a result, it's better to reference the USEPA's current guidelines.

Table 5 - PA's soil screening levels

PFAS	Resident Soil (2021) mg/kg (ppm)	µg/kg (ppb)	Resident Soil to Groundwater (2021) mg/kg (ppm)	µg/kg (ppb)	Groundwater (2024) µg/L (ppb)	ng/L (ppt)
PFOA	4.4	4400	0.007	7	0.004	4
PFOS	4.4	4400	0.007	7	0.004	4
PFNA					0.01	10
PFHxS					0.01	10
PFHpA						
PFBS	66	66000	1	1000	2	2000
HFPO-DA					0.01	10

Figure 3 – Taken from: https://www.dep.pa.gov/Business/Land/LandRecycling/Standards-Guidance-Procedures/Pages/Statewide-Health-Standards.aspx

The United States Environmental Protection Agency (EPA) has established maximum contaminant levels (MCL) for the per- and polyfluoroalkyl substances (PFAS) compounds listed below. These MCLs will become the Statewide health standard medium-specific concentration (MSC) values for groundwater effective June 25, 2024.

The new values are:

Regulated Substance	CASRN	Used Aquifers								Nonuse Aquifers			
		TDS ≤ 2500				TDS > 2500							
		R		NR		R		NR		R		NR	
HEXAFLUOROPROPYLENE OXIDE (HFPO) DIMER ACID (Gen-X) *	13252-13-6	0.01	M	0.01	M	1	M	1	M	0.01	M	0.01	M
HEXAFLUOROPROPYLENE OXIDE (HFPO) DIMER ACID AMMONIUM SALT (Gen-X) *	62037-80-3	0.01	M	0.01	M	0.1	M	0.1	M	0.01	M	0.01	M
PERFLUOROBUTANE SULFONIC ACID (PFBS) *	375-73-5	2	H	2	H	200	H	20	H	2	H	2	H
PERFLUOROHEXANE SULFONIC ACID (PFHxS) *	108427-53-8	0.01	M	0.01	M	1	M	1	M	0.01	M	0.01	M
PERFLUORONONAOIC ACID (PFNA) *	72007-68-2	0.01	M	0.01	M	1	M	1	M	0.01	M	0.01	M
PERFLUOROOCTANE SULFONATE (PFOS)	1763-23-1	0.004	M	0.004	M	0.4	M	0.4	M	0.004	M	0.004	M
PERFLUOROOCTANOIC ACID (PFOA)	335-67-1	0.004	M	0.004	M	0.4	M	0.4	M	0.004	M	0.004	M

* In addition to meeting the individual MSC, if more than one of the marked compounds (Gen-X, PFBS, PFHxS, PFNA) are detected at any concentration in a sample, a Hazard Index (HI) must be calculated using the equation below. The HI MSC is met in this case by maintaining a rolling average HI of less than one for the most recent four quarters of samples utilizing the equation:

$$HI = \left(\frac{C_{Gen\text{-}X}}{0.01}\right) + \left(\frac{C_{PFBS}}{2}\right) + \left(\frac{C_{PFNA}}{0.01}\right) + \left(\frac{C_{PFHxS}}{0.01}\right)$$

Where: All concentrations are in µg/L

$C_{Gen\text{-}X}$ = concentration of Gen-X compounds
C_{PFBS} = concentration of PFBS
C_{PFNA} = concentration of PFNA
C_{PFHxS} = concentration of PFHxS

b. United States Environmental Protection Agency Guidelines

As stated previously, In May 2024 the United States Environmental Protection Agency updated their Regional Screening Levels (RSL) for many chemicals, including many PFAS (Table 6, S3, and S4). This update reflected their recent creation of drinking water standards for PFOS, PFOA, PFBS, PFHxS, PFNA, and HFPO-DA. These new PFAS standards were more stringent than similar guidance that existed prior.

Table 6 - USEPA's Soil Screening Levels

	Resident Soil		Resident Soil to Groundwater	
PFAS	mg/kg (ppm)	µg/kg (ppb)	mg/kg (ppm)	µg/kg (ppb)
PFOA	*0.000019**	*0.019*	*0.00000004*	*0.00004*
PFOS	0.0063	6.3	0.000015	0.015
PFNA	0.19	190	0.00025	0.25
PFHxS	1.3	1300	0.00017	0.17
PFHpA				
PFBS	19	19000	0.003	3
HFPO-DA	0.23	230	0.000015	0.015

* Derived from carcinogenic risk

Soil Screening Levels are not national cleanup standards. They signify the need for further study or investigation of a site. Essentially, they note that risk could be present at the site, but they are not, by themselves, sufficient to determine that risk.

The scope of these USEPA screening levels are:

- Direct ingestion (of the soil)
- *Inhalation of volatiles and fugitive dusts*
- Ingestion of contaminated groundwater caused by migration of chemicals through soil to an underlying potable aquifer
- Dermal absorption
- Ingestion of homegrown produce that has been contaminated via plant uptake
- Migration of volatiles into basements.

Given that the site is an agricultural field intended for the application of waste treatment biosolids, particular emphasis should be placed on inhalation of volatiles and fugitive dusts, ingestion of

contaminated groundwater caused by migration of chemicals through soil to an underlying potable aquifer, and ingestion of produce that has been contaminated via plant uptake (highlighted above).

As stated before, screening levels are meant to signify the potential for risk at a site. In this instance, the result of the intended use (application of waste treatment biosolids) is the contamination of the site. Contamination of this site will not be of some sort of post hoc result, previously thought to be safe chemicals, or unintendedly environmental spill, but the intentional permeant contamination with chemicals that are environmentally mobile, bioaccumulative, toxic, carcinogenic, and persistent. Contaminating soil up to the point of these screening levels would result in the intentional introduction of risk where risk was not previously present. Additionally, since one of the primary toxins in question are PFAS, this contamination will essentially be permanent and will not wane over time like many other contaminants.

c. Comparing "Consumptive Risk Soil Level" to Similar USEPA Guidelines

Table 7 contains the CRSL values compared to USEPA Residential soil and soil-to-groundwater screening levels. CRSL values were developed using Pennsylvania's DPAG RfDs solely with agricultural exposure through plant consumption in mind, as opposed to the USEPA's values, which have several aspects to their values. As can be seen in Table 7, CRSL PFAS values fit within the USEPA's soil screening levels.

Table 7 – Comparing CRSL to EPA Soil Screening Levels

PFAS	"Consumptive risk soil level" (CRSL) (ng/g, ppb) Upper CI for a 50 kg adult	USEPA's Resident Soil Screening Levels (µg/kg, ppb)	USEPA's Resident Soil to Groundwater Levels (µg/kg, ppb)
PFOA	0.6	0.019	0.00004
PFOS	1.0	6.3	0.015
PFNA	0.4	190	0.25
PFHxS	0.5	1300	0.17
PFHpA	0.6		
PFBS	1.8	19000	3
GenX (HFPO-DA)	11.0	230	0.015

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Supplemental information

Table S1 - PA's soil screening Levels (2021, 25 Pa. code chapter 250)

REGULATED SUBSTANCE	CASRN	Residential	Non-Residential	
			Surface Soil	Subsurface Soil
		0-15 feet	0-2 feet	2-15 feet
PERFLUOROBUTANE SULFONATE (PFBS)	375-73-5	66	960	10,000
PERFLUOROOCTANE SULFONATE (PFOS)	1763-23-1	4.4	64	190,000
PERFLUOROOCTANOIC ACID (PFOA)	335-67-1	4.4	64	190,000
		mg/kg Ingestion	mg/kg Ingestion	mg/kg Cap

Table S2 - PA's soil-to-groundwater screening Levels (2021, 25 Pa. code chapter 250)

REGULATED SUBSTANCE	CASRN	Used Aquifers								Nonuse Aquifers				Soil Buffer Distance (feet)
		TDS ≤ 2500				TDS > 2500								
		Residential		Nonresidential		Residential		Nonresidential		Residential		Nonresidential		
		100 X GW MSC	Generic Value	100 X GW MSC	Generic Value	100 X GW MSC	Generic Value	100 X GW MSC	Generic Value	100 X GW MSC	Generic Value	100 X GW MSC	Generic Value	
PERFLUOROBUTANE SULFONATE (PFBS)	375-73-5	1	NA	2.9	NA	100	NA	290	NA	1	NA	2.9	NA	NA
PERFLUOROOCTANE SULFONATE (PFOS)	1763-23-1	0.007	NA	0.007	NA	0.7	NA	0.7	NA	0.007	NA	0.007	NA	NA
PERFLUOROOCTANOIC ACID (PFOA)	335-67-1	0.007	NA	0.007	NA	0.7	NA	0.7	NA	0.007	NA	0.007	NA	NA
		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		

GW = Groundwater

MSC = Medium specific concentration

TDS = Total Dissolved Solids

Table S3 - USEPA Regional Screening Level (RSL) Resident Soil Table (May 2024) Values

		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Child Hazard Index (HI) = 1			
PFAS	CAS No.	Ingestion (mg/kg)	Dermal	Inhalation	**Carcinogenic**	Ingestion Child (mg/kg)	Dermal Child	Inhalation Child	**Noncarcinogenic Child**
PFOA	335-67-1	0.000024	0.000084		**0.000019**	0.0023	0.0099		**0.0019**
PFOS	1763-23-1	0.018	0.063		**0.014**	0.0078	0.033		**0.0063**
PFNA	375-95-1					0.23	0.99		**0.19**
PFHxS	355-46-4					1.6	6.6		**1.3**
PFHpA									
PFBS	375-73-5					23	99		**19**
HFPO-DA	13252-13-6					0.23			**0.23**

Table S4 - USEPA Regional Screening Level (RSL) Resident Soil to Groundwater Table (May 2024) Values

		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Child Hazard Index (HI) = 1					Protection of Groundwater soil screening level	
PFAS	CAS No.	Ingestion (ug/L/)	Dermal	Inhalation	Carcinogenic	Ingestion Child (ug/L)	Dermal Child	Inhalation Child	Noncarci-nogenic Child	MCL (ug/L)	**Risk-based SSL (mg/kg)**	MCL-based SSL (mg/kg)
PFOA	335-67-1	0.0000027	0.0015		0.0000027	0.0006	0.36		0.0006	0.004	**0.00000004**	0.000061
PFOS	1763-23-1	0.002			0.002	0.002			0.002	0.004	**0.000015**	0.000031
PFNA	375-95-1					0.06	2.8		0.059	0.01	**0.00025**	0.000042
PFHxS	355-46-4					0.4	22		0.39	0.01	**0.00017**	0.0000042
PFHpA												
PFBS	375-73-5					6	8400		6		**0.003**	
HFPO-DA	13252-13-6					0.06	0.019		0.015	0.01	**0.000015**	0.00001