CENTER FOR PUBLIC ENVIRONMENTAL OVERSIGHT
A project of the Pacific Studies Center
P.O. Box 998, Mountain View, CA 94042
Voice/Fax: 650-961-8918 <lsiegel@cpeo.org> http://www.cpeo.org

---

TO: Army Corps of Engineers, Buffalo District at celrb-micron.public.comments@usace.army.mil
FROM: Lenny Siegel, Center for Public Environmental Oversight
DATE: April 2, 2023
SUBJECT: Environmental Impact Statement (EIS) Scope of Work for Micron New York Semiconductor Manufacturing Project

Thank you for the opportunity to comment on the Scope of Work for the Micron New York Semiconductor Manufacturing Project's Environmental Impact Statement, under the National Environmental Policy Act (NEPA) as announced in the March 5, 2024 *Federal Register* (https://public-inspection.federalregister.gov/2024-04709.pdf).

My comments will focus on the use and release of hazardous substances during the operation of the facility, but I will also briefly address the impacts to the wetlands ecosystem centered on the proposed development site.

As the first EIS being prepared for a "greenfield" CHIPS Act project, this document not only has local significance, but it may also serve as a national model for subsequent CHIPS environmental reviews.

Semiconductor production inherently uses substances hazardous to humans and the natural environment. It is imperative, therefore, to inform the public, first responders, and operators of public infrastructure, such as wastewater treatment plants, about the full chemical landscape. The EIS should not only disclose the use of such substances, but it also should provide a roadmap for transparency over the lifetime of the facility.

The NEPA process provides an opportunity to identify and minimize, in advance, the environmental hazards of semiconductor production. By doing so, it can lead to appropriate regulation, research on waste management and pollution prevention, and investments in safer facilities.

Semiconductor production is essentially a series of chemical processes that use a wide variety of hazardous substances. The industry explains, "While in the 1980s semiconductor fabs used fewer than 20 elements, today they are using over 50% of the nonradioactive elements in the periodic table."[1] Those include toxic heavy metals. The American Chemistry Council states, "it takes up to 500 highly specialized chemicals to manufacture one semiconductor chip."[2] Yet there is apparently no public list of such chemicals, and it is likely that few of them were studied for their toxicity before introduction into production.

The industry is a major user of Per- and Polyfluorinated Substances (PFAS), also known as "Forever Chemicals" because they persist and bioaccumulate in the environment and even human bloodstreams. These compounds are toxic, even at extremely low exposure concentrations, through multiple pathways. But industry has become reliant on PFAS without first examining the human and environmental risks. It explains, "Without PFAS, the ability to produce semiconductors (and the facilities and equipment related to and supporting semiconductor manufacturing) would be put at risk."[3]

Use and release of the industry's hazardous building blocks are regulated by both state and federal statutes and regulations, but the public is generally unaware of the series of upcoming permit applications that Micron is expecting to make. The EIS should list **all** anticipated permitting processes, with the anticipated schedule of public comment periods, and it should require public notification to interested parties of each permit application as it is submitted.

It should also identify hazardous substances, whether or not they currently have promulgated exposure standards. For example, the industry reports, "Most PFAS are not regulated pollutants and therefore unless company specific provisions are in place, the wastewater from processes that use aqueous wet chemical formulations that contain PFAS would likely be discharged to the publicly owned treatment works without substantive removal of the PFAS."[4]

---

[1] "Background on Semiconductor Manufacturing and PFAS," Semiconductor Association (SIA) PFAS Consortium, May 17, 2023, p. 54. The SIA PFAS Consortium is made up of chipmakers and their suppliers of equipment and materials. To sign up to receive their technical papers, go to https://www.semiconductors.org/pfas/ .

[2] Chris Jahn, "Biden's EPA could jeopardize his key policies by imposing sweeping new environmental rules on chemicals used for chips manufacturing, *Fortune*, March 29, 2024

[3] "The Impact of a Potential PFAS Restriction on the Semiconductor Sector," SIA PFAS Consortium, April 13, 2023, p. 3.

[4] *ibid*.

Wastewater

The CHIPS Program Office at the Department of Commerce has observed, in its first environmental review of semiconductor production, concluded: "Wastewater discharge from semiconductor manufacturing facilities presents the greatest risk for PFAS contamination of the environment."[5] This should serve as a starting point for the Micron EIS.

In fact, given the vast number of PFAS used by the semiconductor industry, the EIS should identify methods for sampling total organic fluorine, not just targeted compounds. As recently as June, 2023, the industry PFAS Consortium wrote, "At present, only a small percentage of PFAS compounds within typical semiconductor wastewater are detectable and quantifiable using conventional U.S. EPA analytical methods for PFAS-containing materials."[6]

This is based upon the findings of academic researchers who concluded that failure to measure total fluorine misses discharges of significant quantities of PFAS pollutants. "[B]ecause many studies of total organic fluorine have shown that total PFAS concentrations are at least 10 times higher than the sum of target PFASs. However, this does reinforce the idea that PFAS monitoring should incorporate complementary target and nontarget analyses or otherwise include measures of total organic fluorine to accurately assess PFAS abundance and potential environmental impacts."[7]

EPA's recently announced Method 1621, "Determination of Adsorbable Organic Fluorine (AOF) in Aqueous Matrices by Combustion Ion Chromatography," is a significant positive step. However, it only measures PFAS that are **adsorbed** to granular activated carbon. It states:

> Short-chain (less than 4 carbons) organofluorine compounds are poorly retained on GAC while long-chain (more than 8 carbons) hydrophobic organofluorine compounds readily adsorb to surfaces. These issues can cause low recoveries for these types of fluorinated compounds.[8]

---

[5] "Draft Programmatic Environmental Assessment (PEA) for Modernization and Internal Expansion of Existing Semiconductor Fabrication Facilities under the CHIPS Incentives Program," U.S. Department of Commerce CHIPS Program Office, December, 2023, p. B-7, https://www.nist.gov/system/files/documents/2023/12/26/CHIPS%20Modernization%20Draft%20PEA.pdf

[6] "PFOS and PFOA Conversion to Short-Chain PFAS-Containing Materials Used in Semiconductor Manufacturing," SIA PFAS Consortium, June 5, 2023, p. 11.

[7] Paige Jacob, Kristas Barzen-Hanson, and Damian Helbling, "Target and Nontarget Analysis of Per- and Polyfluoralkyl Substances in Wastewater from Electronics Fabrication Facilities," *Environmental Science & Technology,* February 16, 2021, p. 2353. https://pubs.acs.org/doi/10.1021/acs.est.0c06690 . This study was sponsored by the semiconductor industry

[8] "Method 1621: Determination of Adsorbable Organic Fluorine (AOF) in Aqueous Matrices by Combustion Ion Chromatography," U.S. EPA Office of Water, January 2024, p. 1, https://www.epa.gov/system/files/documents/2024-01/method-1621-for-web-posting.pdf

Documentation should not be confined to chemical inputs. In a more recent study, Jacob and Helbling reported, “However, the exact identities of these constituents are unknown and transformation reactions that may occur during photolithography may result in the formation of unknown or unexpected PFASs.”[9] Measurement of such PFAS should not be confined to target compounds or those captured through carbon adsorption, but should use methods designed to identify and quantify all PFAS in production wastewater.

The EIS should identify the points of production where PFAS are used and released, so the Oak Orchard Wastewater Treatment Plant’s Wastewater Discharge Permit can mandate pre-treatment for PFAS at the point of use, before comingling with other wastes. Because current treatment technologies do not adequately remove all PFAS—particularly the short-chain compounds reportedly used in semiconductor production—the EIS should identify research objectives for more complete treatment technologies and explain the need to improve treatment as new technologies are proven. In the absence of complete treatment, the Oak Orchard Plant is likely to release PFAS into the environment, both through its liquid effluent and the biosolids it generates.

Since most of the PFAS used and generated in semiconductor production have not been subject to thorough toxicity studies—indeed, most are not even identified—the goal of treatment should be to remove total organic fluorine, as well as known, targeted compounds. In the future more PFAS compounds are likely to be subjected to enforceable environmental standards, many at very low concentrations.

All PFAS are believed to be persistent and bioaccumulative, so their impact on the environment is generally irreversible. Ling found, “current costs to remove and destroy the total PFAS mass released annually into the environment would likely exceed the global GDP of 106 trillion USD. While this level of treatment is not technically or economically achievable, it highlights the unaffordability of using environmental remediation alone to manage environmental PFAS stocks.”[10] That is, an ounce of avoided releases is worth orders of magnitude of cure.

While PFAS are today the most significant wastewater challenge, other waste chemicals must be addressed. “Traditional on-site treatment includes fluoride and ammonia removal as well as pH neutralization.”[11] Discharges from semiconductor wafer fabrication plans not only pose a direct threat to the environment, but they may undermine the general effectiveness of

---

[9] Paige Jacob and Damian E. Helbling**,** “Exploring the Evolution of Organofluorine-Containing Compounds during Simulated Photolithography Experiments,” *Environmental Science and Technolog**y,*** August, 2023**,** https://pubs.acs.org/doi/pdf/10.1021/acs.est.3c03410?download=true . This study was sponsored by the semiconductor industry and the National Science Foundation.

[10] Alice L. Ling, “Estimated Scale of Cost to remove PFAS from the Environment at Current Emission Rates,” *Science of the Total Environment,* March, 2024, p. 2, https://doi.org/10.1016/j.scitotenv.2024.170647

[11] Jim Lozier (Jacobs), “Water Needs for Semiconductor Facilities—What Are the Issues and Challenges?” Presentation to March 13, 2023 Healthy Waters Conference, Syracuse, New York, p. 6.

wastewater treatment plants. A Global Foundries representative explained, “Influent to [Public Owned Treatment Works] must be managed to prevent inhibition of biomass.”[12]

Workplace Exposures

Furthermore, potential workplace exposures should not be ignored because exposures are below the Occupational Exposure Level (OEL) or even a fraction of the OEL, as industry suggests. What little we know about current practices comes from the Semiconductor PFAS Consortium’s May, 2023 paper, “Background on Semiconductor Manufacturing and PFAS.” It states (emphasis added):[13]

> **12.2 SEMI Safety Guidelines for Tool Design**
>
> Most semiconductor manufacturers have a company requirement to purchase semiconductor manufacturing tools designed and certified to comply with SEMI safety guidelines; for a complete list of these safety guidelines, see Appendix C. SEMI safety guidelines cover many aspects of manufacturing tool standardization and design conventions that have an enabled a fungible supply of immensely complex and specialized manufacturing tools for installation in fabs across the world.
>
> In particular, the SEMI S2 safety guideline addresses design and performance standards for assuring the isolation or protection of clean-room workers from the chemicals used in semiconductor manufacturing tools. The SEMI S2 safety guideline distinguishes between the concentration of a chemical in the general ambient air surrounding a semiconductor manufacturing tool and the concentration within a “worst-case” PBZ. The SEMI S2 safety guideline also differentiates between three states of tool operation:
>
> • SEMI S2, 23.5.1 states that there should be no chemical emissions to the workplace environment during normal equipment operation. Measurements that show the air concentration to be less than **1% of the occupational exposure limit (OEL)** in the worst-case PBZ demonstrate conformance to this requirement.
>
> • SEMI S2, 23.5.2 states that chemical emissions during maintenance activities should be minimized. Measurements that show a concentration in the anticipated worst-case PBZ during maintenance activities as less than **25% of the OEL** demonstrate conformance to this requirement.
>
> • SEMI S2, 25.5.3 states that chemical emissions during equipment failure should be minimized. Measurements that show a concentration in the anticipated worst-case PBZ during a realistic worst-case system failure as less than **25% of the OEL** demonstrate conformance to this requirement.

However, in most cases OELs, such as the Occupational Safety and Health Administration’s (OSHA) Permissible Exposure Limits (PELs), are orders of magnitude above what the science—including U.S. EPA studies—dictates. Even 1% is unprotective.

---

[12] David Speed (Global Foundries), “Environmental Challenges and Research Needs, “Presentation to March 13, 2023 Healthy Waters Conference, Syracuse, New York, p. 7

[13] “Background on Semiconductor Manufacturing and PFAS,” p. 25

Solid Wastes and Hazardous Substances

Largely due to public oversight and regulation, the semiconductor industry's handling of solid wastes and hazardous materials has improved since the Wild West of the 1960s and 1970s. The EIS should describe any permitting required for the Treatment, Storage, and Disposal of hazardous materials and solid wastes, and it should list the storage requirements, such as double-walled tanks and piping, necessary to prevent environmental releases. It should also explain how employees should be educated about the risk from leaks and spills, as well as what to do when they occur. The EIS should identify job security practices necessary to ensure that employees feel free to report workplace safety issue.

The EIS should identify to what degree disposal—including landfilling and incineration—will create off-site hazards. Industry reports, "Organic waste, including organic liquids containing PFAS, is typically segregated, collected, and containerized to be treated at an offsite licensed treatment and disposal facility, as a blended fuel by high temperature incineration or reprocessing."[14] However, perfluorinated compounds are particularly difficult to destroy using incineration. Furthermore, even when permitted by regulatory agencies, incineration may release products of incomplete combustion into the atmosphere.

The EIS should also identify other toxic substances, such as solvents, that may pose hazards both within the chipmaking plant and beyond. Solvents, for example, can be released directly into the air, or they can be released in liquid form, polluting groundwater and air. In its early years, the industry relied heavily on trichloroethylene (TCE), poisoning groundwater throughout Silicon Valley and to this day impacting overlying buildings with vapor intrusion.[15]

More recently, producers have relied on N-methyl-pyrrolidone as a solvent. The CHIPS Office reports, "For example, traditional solvents contain N-methyl-pyrrolidinone (NMP), which is known to cause harm to reproductive systems. Therefore, some manufacturers have begun to replace traditional solvents with NMP-free varieties," citing the efforts of United Microelectronics, a Taiwan-based chipmaker.[16] What solvents will be used at the Micron plant, and has their toxicity been adequately researched?

Air Quality

The EIS should identify the known or potential emissions of air pollutants, extremely hazardous substances, and greenhouse gases. The semiconductor industry uses lethal gases such as arsine and phosphine, as well as toxic gases such as hydrogen chloride (the gaseous form of hydrochloric acid). The EIS should identify those potential releases, and Micron should be required to create Risk Management Plans that would notify the public and first responders of the presence of such substances. We believe the thresholds for reporting should be based upon

---

[14] "Background on Semiconductor Manufacturing and PFAS," p. 30.
[15] See, for example, Peter Strauss, "The MEW/Moffett Field Superfund Site: A Guide to Vapor Intrusion Progress," Center for Public Environmental Oversight, October, 2022, http://www.cpeo.org/pubs/MEW-VI-Progress.pdf
[16] "Draft Programmatic Environmental Assessment," p. 53

California's Accidental Release Program list, rather than U.S. EPA's Risk Management Program list. For example, U.S. EPA shows a reporting threshold for arsine, a deadly, gaseous form of arsenic, of 1,000 pounds.[17] California's threshold is 100 pounds.[18] Employees should be warned about the toxicity of gases used by the industry and trained to protect themselves from potential releases, both at low levels associated with chronic toxicity as well as higher levels with acute toxicity.

The planned use and storage of extremely hazardous substances should be taken into account for site planning. In particular, the location of the much-needed childcare center should be evaluated based upon both proximity and wind direction.

The CHIPS Office summary of greenhouse gas (GHG) emissions in the Draft Programmatic Environmental Assessment suggests the EIS will include careful analysis. The semiconductor industry causes the release of GHGs due to both its massive energy use and directly in the production process. The CHIPS Office reports that the industry has significantly reduced its emissions of fluorinated gases, its largest manufacturing contributor of GHGs. We are concerned, however, that treatment in the form of incineration of fluorinated gases may cause the release of products of incomplete combustion and other pollutants.[19]

Life-Cycle Environmental Impacts

The EIS should also document which hazardous substances remain in finished semiconductor products, including packaging. At the end-of-life, are there mechanisms for preventing the environmental release of semiconductor hazardous substances? Industry's PFAS Consortium reports, "At the end-of-life of the product containing the semiconductor, or any parts replaced during the manufacture of semiconductors, would enter waste disposal streams where any PFAS contained therein could enter the environment."[20] Are manufacturers responsible for end-of-life pollution?

Wetlands

At the March 19 scoping meeting, a Micron representative explained that the company planned to locate its new buildings to minimize the impact on the 244 acres of designated wetlands on the property, and that it would develop plans to mitigate the loss of bat and bird habitat. That's a good start. But when I visited the property, it was clear that the wetlands are part of a larger

---

[17] U.S. EPA Risk Management Program, "List of Regulated Substances and Thresholds for Accidental Release Program," viewed on April 2, 2024 https://www.epa.gov/rmp/list-regulated-substances-under-risk-management-program-program

[18] California Code of Regulations, "Regulated Substances for Accidental Release Prevention," viewed on April 2, 2024 https://govt.westlaw.com/calregs/Document/IC187A010E14811EEA00AACD3D3AE5397?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)&bhcp=1

[19] "Draft Programmatic Environmental Assessment." See especially pp. 27 and 82.

[20] "The Impact of a Potential PFAS Restriction on the Semiconductor Sector," p. 90,

ecosystem. That is, the critters don't know the official wetlands boundaries. The wetlands mitigation program should analyze the impact of construction on adjacent uplands to initiate steps to minimize the ecological impact.

In Conclusion

Finally, there are those who argue that a thorough environmental review would unnecessarily delay the operation of new, advanced wafer fabrication plants. I find it hard to believe that documenting potential hazardous substance and waste impacts in advance would hamper the construction of a factory that is not expected to begin construction until 2025. Micron—indeed, all semiconductor manufacturers—**should** already know what hazardous substances it uses and releases. Shouldn't the public also know? The semiconductor and computer manufacturing industry, such as IBM's complex in Endicott, New York or in my Silicon Valley neighborhood, has a long history of causing pollution that threatens public health and the environment. An industry that claims that PFAS—chemicals that are persistent, bioaccumulative, and extremely toxic in low concentrations—are essential to its operations should be required to **come clean** about its environmental and public health hazards.