

## **Floor Coverings**

### **Covered Products:**

Hard and “resilient” flooring products, carpeting sheet goods and tile goods for new installations and for patching or replacements of existing carpet installations. Backing and adhesives related to carpet installations, hard and “resilient” flooring.

### **Goal:**

To set to set a hierarchy of flooring covering preferences, establish minimum environmental goals for flooring installations in state properties, and provide recommendations for additional aspects of flooring performance, cleaning and maintenance, for a healthier indoor environment.

### **Background:**

The procurement of hard and “resilient” flooring over carpet is desired to avoid adverse human health and environmental impacts.

Carpet is a significant source of landfill waste due to the frequency of replacement. It also can be a source of chemical emissions (VOCs and SVOCs) into indoor air. Carpets and other “soft” surfacing can capture compounds (e.g. particles such as dust and dirt), adversely affecting air quality over time.

With proper specification, emissions or chemical off gassing associated with new carpeting, as well as installation waste, can be reduced. In addition, technologies for recycling carpeting back into new carpets, or for making new products, are being increasingly commercialized and are increasingly available.

PVC is a commonly used compound in “resilient” flooring products and in carpet backing. It is predominately chlorinated and is a halogenated compound. A synthesis, which begins by reacting ethylene (derived from fossil fuels) and chlorine gas creates ethylene dichloride (EDC). EDC is converted to vinyl chloride monomer (VCM), and the VCM is polymerized into polyvinyl chloride resin. Depending on the performance attributes desired in the products being made from the resin, various additives (usually encompassing, but not limited to stabilizers and plasticizers) are incorporated to form a final PVC compound. For example, one type of additive commonly used in PVC is plasticizer, used to make products flexible that would otherwise be rigid. Phthalates, once widely used as plasticizers, are being phased out of manufacturing, but are being replaced with other plasticizers which have not undergone thorough peer-review study. Lead and cadmium, once widely used as stabilizers, are almost completely phased out of new manufacturing, but are commonly being replaced with organotin, which are classified as a group of persistent bio-accumulative and toxic substances (PBTs).

Some carpets and coatings on hard surface flooring contain perfluorinated chemicals (PFCs) (see definition below). PFCs are widely used to make everyday products more resistant to stains, grease and water. For this reason, they have been intentionally added to carpets and coatings to aid in stain and water repellency.

Research into the human health risks associated with PFCs is ongoing. Most of the science on the health risks associated with long-term human exposure to PFCs focuses on two chemical types of PFCs – perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) – that were used for decades to manufacture hundreds of different products before studies indicated that exposure to them over certain levels may result in adverse health effects.

In 2006, the U.S. Environmental Protection Agency (EPA) launched its PFOA Stewardship Program, under which major manufacturers phased out the use of certain long-chain PFCs of concern. By 2015, PFOAs were voluntarily phased out from the U.S. carpet industry. To replace these chemicals, manufacturers developed short-chain alternatives.

Research into the human health risks associated with both long- and short-chain PFCs is ongoing. In 2003, EPA nominated thirteen PFCs closely related to PFOA and PFOS as a class for study by the National Toxicology Program (NTP) due to potential similarities among these PFCs in chemical properties and toxicity. According to a July 2016 fact sheet issued by the National Institutes of Health (NIH), the concerns driving continued study of PFCs as a class include NTP, eight of those PFCs similar to PFOA and PFOS, but with different numbers of carbons, are currently being studied due to concerns based on widespread exposure to humans, persistence in the environment, observed toxicity of certain PFCs in animals (such as PFOA and PFOS), and “insufficient information to properly assess human health risk across the entire structural class.” According to The NIH’s Substances of Concern Database (as of April 13, 2018),

“shorter chain PFCs (those with four to six carbons) are considered to be less toxic than longer chain PFCs, however, there is limited toxicological data on shorter chain PFCs and, since they are similarly structured and could therefore have similar properties, using these as alternatives to their longer chain counterparts could result in a regrettable substitution.”

The NIH’s recommended reduction strategies include “selecting products and materials that do not contain PFCs,” for example, “carpeting . . . made without PFCs.”

The Washington State Departments of Ecology and Health released an *Interim Action Plan for Per- and Polyfluorinated Alkyl Substances* in April 2018 that summarizes the latest science concerning the safety of this major class of PFCs:

“Some short-chain PFAS appear to be less bioaccumulative in people than long-chain compounds, but publicly available data on their hazards is limited to a few compounds. Like long-chain PFAS, many of the short-chain substances are

extremely persistent or degrade into extremely persistent forms. Short-chain PFAS also tend to be more water soluble and more mobile than the long-chain substances. This means they can move more easily through soil to contaminate groundwater or surface water, and are harder to filter out of drinking water. The short-chain replacements may be regrettable substitutes for PFOA and PFOS. If environmental exposures to short-chain PFAS are found to pose health risks to people or the environment, mitigation will be difficult and expensive.”

Avoiding the use of PFCs in carpet and coatings can help to reduce human exposure and potential sources of PFCs in the environment. A 2016 study at a municipal landfill linked carpet waste to two shorter chain PFCs which were released into landfill leachate. While landfill leachate is treated prior to becoming effluent into the environment, many PFCs are not treatable and sometimes even increase as a result of treatment.<sup>i</sup>

### **Definitions:**

**Volatile Organic Compounds (VOC)** – Organic chemicals that easily enter the air as gases from some solids or liquids. They are ingredients in many commonly used products and are commonly found in indoor settings. VOCs are used and produced in the manufacture of paints, adhesives, some building materials, petroleum products, pharmaceuticals, and refrigerants.

**Semivolatile Organic Compounds (SVOC)** – A subgroup of VOCs that tend to have a higher molecular weight and higher boiling point temperature than other VOCs. They are present partly as gaseous airborne chemicals and partly as chemicals absorbed on indoor surfaces and onto microscopic airborne and settled particles. SVOCs gases or suspended particles can be inhaled, absorbed through the skin, or consumed from food contact. Common SVOCs include Polyaromatic Hydrocarbons (PAHs), Polychlorinated biphenyls (PCBs), Polybrominated flame-retardants, Perfluoroalkyl acids (PFAAs), Phthalates and Pesticides.

**Polyvinyl Chloride (PVC)** – An odorless and solid plastic made up of vinyl chloride molecules that link together to form a polymer, found in carpet backing and in vinyl flooring. Vinyl chloride, which is classified as a human carcinogen, and ethylene dichloride, also known as 1,2-dichloroethane, which has been described by the National Toxicology Program (NTP) as reasonably anticipated to be a human carcinogen, are the basic building blocks of PVC. Chemicals commonly added to PVC include phthalates, which are developmental and reproductive toxins for which the U.S. Environmental Protection Agency (EPA) has issued a Chemical Action Plan under the Toxic Substances Control Act (TSCA). Where phthalates have been phased out, other plasticizers have been substituted, most of which need to undergo further study to screen for toxicants and environmental hazards. The combustion of waste streams containing PVC under both controlled and uncontrolled conditions is a significant source of dioxins and furans (which have been identified as priority chemicals for elimination or reduction by EPA’s National Waste Minimization Program), and polychlorinated

biphenyls (PCBs) (designated as reasonably anticipated to be a human carcinogen by the NTP).

**PFC** – Any perfluorinated or polyfluorinated chemical, including but not limited to long- and short-chain per- or polyfluorinated alkyl compounds (PFASs), fluorinated sulfonate compounds, fluorinated polyethers, and fluorinated polymers.

**Flame Retardant Chemicals** - Any chemical or chemical compound for which a functional use is to resist or inhibit the spread of fire. Flame retardant chemicals include, but are not limited to, halogenated, phosphorous-based, nitrogen-based, and nanoscale flame retardants, and any chemical or chemical compound for which "flame retardant" appears on the substance Safety Data Sheet (SDS) pursuant to Section 1910.1200(g) of Title 29 of the Code of Federal Regulations.

**Coal Fly Ash** – A by-product of coal-fired power plants. Mercury, arsenic, cadmium, hexavalent chromium, polycyclic aromatic hydrocarbons, dioxins and lead can be present in coal fly ash and they are either or both neurotoxicants and reproductive toxins.

**California Proposition 65** - Known as the Safe Drinking Water and Toxic Enforcement Act of 1986, requires the State of California to publish a list of chemicals known to cause cancer, birth defects or other reproductive harm. The California Office of Environmental Health Hazard Assessment follows a rigorous scientific and open, public process to evaluate available scientific information and lists chemicals based on recommendations from State committees of scientists and health professionals, presence on an authoritative list of chemicals of concern (e.g. IARC or NTP), identification by a state or federal agency as a carcinogen or teratogen, or satisfaction of certain criteria defined in the California Labor Code.

**Antimicrobial agents** – Substances or mixtures of substances that destroy or suppress the growth of microorganisms on inanimate objects or surfaces.

**Ortho-phthalate** – Also used interchangeably with “Phthalates.” This group of substances have six chemicals listed on California’s Proposition 65 List of Chemicals, and with regards to flooring, they are used as plasticizers for softening PVC.

**Association of Occupational and Environmental Clinics (AOEC)** - A non-profit organization committed to improving the practice of occupational and environmental health through information sharing and collaborative research. Some adhesives may contain ingredients that can cause or worsen asthma in a workplace environment. Of particular concern are substances that can cause respiratory sensitization or are generally known to be asthmagens. These substances are noted on an asthmagen list that is maintained by the Association of Occupational and Environmental Clinics (AOEC) with an Rs or G code. Asthmagens that may be found in flooring components or adhesives include epoxy resins, diisocyanates, latex, and urea formaldehyde. A full

list of AOEC asthmagens can be found  
at: <http://www.aoecdata.org/expcodelookup.aspx>

**LEED (Leadership in Energy and Environmental Design)** - An internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies intended to improve performance in metrics such as energy savings, water efficiency, CO2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts.

### **Floor Coverings -**

**Hard Flooring** – Non-textile flooring which includes, but is not limited to, hardwood, engineered wood, marble, stone, ceramic tile, fluid-applied, and wood laminate flooring products.

**“Resilient” Flooring** – Non-textile flooring which includes, but is not limited to, linoleum, cork, rubber and vinyl (PVC) flooring products.

**Carpet tiles** – Textile flooring, also known as carpet squares or modular carpet, which are small pieces of carpeting laid as tiles to cover a floor.

**Broadloom carpet:** Textile flooring carpet that is woven on a wide loom or is machine-tufted, shipped in rolls.

### **Standard Setting and Certifying Programs:**

**The Cradle to Cradle Certified Products Standard at the Silver level or higher** - A multi-attribute eco-label that evaluates a wide range of products across five categories of human and environmental health. The standard includes material health, material reutilization, renewable energy and carbon management, social fairness and water stewardship. For more information, visit: <http://www.c2ccertified.org>

**Living Building Challenge™ Declare® label** – an international sustainable building certification program by the International Living Future Institute. The program comprises seven performance areas: site, water, energy, health, materials, equity and beauty which promotes sustainability in the built environment.

**UL Greenguard Gold** – The strongest tier which requires low-emitting products to meet the California 01350 emissions test. For more information, visit: <http://greenguard.org/en/index.aspx>

**Floorscore by Scientific Certification System (SCS)** – Certifies low-emitting flooring products using the California 01350 emissions testing method. Covers hardwood,

engineered wood, wood laminate, and other types of flooring.  
<https://www.scsglobalservices.com/services/floorscore>

**Carpet and Rug Institute (CRI) Green Label Plus** – Carpet and Rug Institute, is a not-for-profit trade association representing the manufacturers of more than 95 % of all carpet made in the United States, as well as their suppliers and service providers. They certify low-emitting carpet and carpet cushions. <http://www.carpet-rug.org/>

**NSF/ANSI 140 Sustainability Assessment for Carpet** – A sustainable carpet assessment standard which establishes performance requirements for public health and the environment. Information regarding the Assessment can be found at [www.green.ca.gov/](http://www.green.ca.gov/). A comprehensive searchable database of all carpet products certified to meet the NSF/ANSI 140-2007 standard can be found at <http://www.carpet-rug.org/green-building-and-the-environment.html>, and can be sorted to show all products certified at the Platinum level by all certifiers.

**Forest Stewardship Council® (FSC)** – The FSC has developed a set of Principles and Criteria for forest management that is applicable to all FSC-certified forests throughout the world. There are 10 Principles and 57 Criteria that address legal issues, indigenous rights, labor rights, multiple benefits, and environmental impacts surrounding forest management. For more information visit the FSC website at: [www.fscus.org](http://www.fscus.org) .

**Sustainable Forestry Initiative® (SFI)** - A chain-of-custody certification that tracks fiber content from certified lands and responsible fiber sourcing through production and manufacturing to the end product. To be certified, companies must be audited to SFI Requirements. Through SFI chain-of-custody certification, a company can identify how much certified, responsible sourcing and/or recycled content is in a product. Chain-of-custody is verified by an independent third-party certification audit. For more information visit the SFI website at: <http://www.sfiprogram.org/>

## **Specifications:**

### **I. Procurement:**

#### **1. Affected entities are encouraged to procure:**

- **Linoleum** - typically derived from bio-based, renewable and non-hazardous ingredients, and is free of the problematic additives used in vinyl products. However, all floors on the market contain a topcoat which may contain substances of concern, and which manufacturers typically do not disclose. These topcoats must contain no intentionally added ingredients as listed under *All Floor Coverings, part ii*.
- **Solid wood flooring (pre-finished)** – A single piece of wood, purchased with a stain and topcoat already applied, this type of flooring allows for the chemically intensive finishing processes to take place in

a factory where there are pollution controls and workers are protected. If possible, find flooring that can be installed without an adhesive. Stains and topcoats must follow the protocol listed under *All Floor Coverings, part ii*.

- **Rubber or Rubber/Cork Flooring (made without crumb rubber)** - Flooring made from new rubber do not contain the legacy contaminants and isocyanate binders often found in recycled crumb rubber floors.

2. If the procurement of the above is not feasible, **affected entities are encouraged to procure:**

- **Biobased Flooring** - Biobased flooring is a category of products that use plastics or other materials derived from plants. These polymers are typically new and rely on proprietary technologies. Without disclosures about the nature of these polymers it is often difficult to assess their hazards. When considering a biobased flooring product, prefer those with a Health Product Declaration, an Environmental Product Declaration or other document providing transparency about the product's content and associated health hazards.
- **Engineered Wood Flooring (pre-finished)** - Engineered wood is a lesser option than solid wood because it requires the use of a binder and other adhesive ingredients; however, an engineered floor can still be a preferable option in terms of user exposures to these chemicals if it is purchased *pre-finished*. Binders must adhere to the protocols listed under *All Floor Coverings part ii*, and adhesives must adhere to the protocols in the referenced adhesives specification. When possible, procure a product that does not require an adhesive for installation.
- **Ceramic Tiles (made in the USA/lead-free with no CRT content)** - Ceramic tiles made without toxic glazes or unglazed. Tiles made in the USA are typically free of lead compounds in their glazes. Look for tile product literature that identifies where they've been made, and what they are made of, including frits, glazes, and pigments.

Avoid tiles with non-specific post-consumer recycled content. These contents may be old cathode ray tubes (CRTs) from TV sets and computer monitors, which contain high concentrations of lead.

- **Solid wood floors (finished on site)** - When the boards are installed unfinished and require stains and topcoats to be applied within the building, those volatile and sometimes flammable chemicals can be brought into the project in an uncontrolled way, exposing installers and others nearby.

3. If the procurement of the above is not feasible, **affected entities are encouraged to procure:**

- **Fluid-applied Flooring** - These polymers (including, but not limited to resins, epoxies and Methyl Methacrylates) are typically new and rely on proprietary technologies. Without disclosures about the nature of these polymers it is often difficult to assess their hazards. Concrete is discouraged due to its high carbon footprint during manufacture, accounting for 5%-6% of greenhouse gases worldwide.
- **Wood Laminate** - Decorative paper infused with a binder over a plank of composite wood. A type of engineered floor. The main difference is laminate cannot be sanded or refinished unlike other engineered wood floors.
- **Carpet tile (with no coal fly ash, no PVC, no PFAS & no polyurethane backing)** – Carpet is difficult to recycle and has been shown to leech toxic chemicals into landfills. Carpet is also known to trap dust and asthmagens which can affect air quality over time, especially without regular carpet cleaning. Procurement of carpet tile is preferred over broadloom carpet so that individual tiles may be replaced when necessary, reducing the amount of carpet being recycled or potentially sent to landfill. If carpet tile is purchased, it must adhere to the further specifications listed under All Floor Coverings. It should also be durable (e.g. low, loop pile, rather than high, cut pile).

4. Flooring products containing PVC, recycled PVC, recycled crumb rubber and CRTs *should not* be procured. Further limitations are listed under *All Floor Coverings, Section II, subpart ii.*

## II. All Floor Coverings:

Where such products are cost competitive over the lifetime of the product and meet form, function and utility requirements, affected entities shall procure floor coverings that meet the following specifications:

- i. Have the following required standards and third party certifications:
  - Cradle to Cradle Certified Silver or higher under v3.1 or Newer
  - Or**
  - Living Building Challenge™ Declare® label

**Or**

- Have an Environmental Product Declaration® (EPD) for a Life-Cycle Analysis (LCA) verified by UL Environment or accredited by ISO14025 and EN15804 and independently verified by a third party

**And**

- Have a Health Product Declaration® (HPD) which reports contents and ingredients as they relate to human health, and is complementary to an EPD.

**And**

- Have at least one of the following Low Emitting Material Indoor Air Quality (IAQ) certifications:
  - UL Greenguard Gold
  - CRI Greenlabel Plus
  - SCS Floorscore Standard

- ii. All floor coverings, including backings, coatings, adhesives and other components **shall contain no intentionally added:**

- *Antimicrobial agents formaldehyde, triclosan and triclocarban* – these are added to raw materials during the manufacture of the product for the sole purpose of preserving the product. Other Antimicrobials are allowed if needed to meet form, function and utility. However, even in these cases, formaldehyde, triclosan and triclocarban shall not be used, and any added antimicrobial must comply with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA);
- *Lead, cadmium, hexavalent chromium, organotins and mercury* - These heavy metals may be found in virgin and recycled vinyl flooring, finishes and carpet components;
- *Flame retardant chemicals* which can be used in floor finishes, coatings, adhesives and carpet padding and backings. Some flame retardants used in carpet are halogenated, which are bio accumulative and linked to hyperactivity, learning

disabilities, reproductive harm, and cancer. Common replacements for the halogenated flame retardants are organophosphate flame retardants, which are linked to endocrine disruption and infertility. Flame retardants can be emitted from carpet into dust and the air both during use and from operations that recycle and dispose of carpet waste;

- *PFCs* which can be found in the nanocoatings of hard surface flooring and in many carpet components;
- *Synthetic styrene butadiene latex* which can be found in wooden floor cushions, wrapping materials, adhesives and carpet backing;
- *Chlorinated compounds* (e.g., polyvinyl chloride (PVC) or vinylidene chloride) which is can be found in vinyl flooring, adhesives, carpet backing and fiber.

iii. In addition, **affected entities shall**, to the maximum extent practicable:

- Prioritize products that can be installed with nails or other mechanical fasteners. Where not feasible:
  - Use adhesives that comply with the *Adhesives* specification, including avoidance of asthmagens as identified by AOEC: <Insert adhesives link when ready>
- Use floor finishes and finish removers that comply with the *Floor Finishes and Finish Removers* specification: <https://www.ogs.ny.gov/GreenNY/specs/green-specs-FloorFinishesRemovers.asp>.
- Clean floor coverings per manufacturer recommendations and by using green cleaning products referenced in the *General Purpose Cleaners* specification: <https://www.ogs.ny.gov/GreenNY/specs/green-specs-GeneralCleaners.asp>
- Develop a Carpet Cleaning and Maintenance Program based on CRI guidelines for commercial applications: [http://www.carpet-rug.org/documents/publications/078\\_carpet\\_maintenance\\_guidelines.pdf](http://www.carpet-rug.org/documents/publications/078_carpet_maintenance_guidelines.pdf)

- Pre-ventilate carpet by unpacking and unrolling to air-out in a well-ventilated, uninhabited space for a minimum of several hours, preferably a few days, prior to installation. Also ventilate during and after installation for a suggested three days. This practice should also be used for hard surface flooring if adhesives/sealants are present.
- iv. Affected entities are encouraged to select materials that conserve resources, and:
- Select products with recycled content.
  - Select products that use 100% recyclable face fiber and backing.
  - Select products without chemicals that are on the Prop 65 list of substances that are known to the State of California to cause cancer, birth defects or other reproductive harm. These may include, for example, benzene, formaldehyde, methylene chloride, n-hexane, perchloroethylene, or toluene.
  - Reduce the State's carbon footprint by procuring local, regional or national products.
    - For projects registered with a LEED rating system, some contribution to achievement of credits may be realized in purchasing units that are manufactured within 500 miles of the project site.

### **III. Hard and “Resilient” Flooring:**

Affected entities shall, to the maximum extent practicable, procure hard and “resilient” flooring which meets the following specifications:

- a. Contains no intentionally added formaldehyde. All composite wood materials, including hardwood plywood, particleboard, or medium density fiberboard, used in floor coverings shall comply with Phase 2 of California's Code of Regulations, Title 17 §93120.2 – Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products.
- b. If procuring floor coverings that contain wood, material must be originally sourced from forestlands participating in an acceptable system or program which certifies sustainable forest management, as determined by the Commissioner of the Department of Environmental Conservation, or his/her designee. Acceptable systems or programs must include the following:

- adherence to management practices which conserve biological diversity, maintain productive capacity of forest ecosystems, maintain forest ecosystem health and vitality, conserve and maintain soil and water resources, and maintain forest contribution to global carbon cycles;
- independent third-party auditing that monitors, measures and reports compliance with system or program principles and guidelines; and
- documentation verifying that the wood-based products used have been obtained from lands enrolled under or participating in an acceptable certification system or program. Examples of approved certification organizations are FSC and SFI.

#### IV. Broadloom carpet and carpet tile

Affected entities shall, to the maximum extent practicable, procure carpet products that meet the following specifications, except in cases where a match of style and lot number (for color) are needed:

- Contains no coal fly ash;
- Contains no polyurethane backing;
- Contains nylon yarn.

Carpet products shall be certified to meet the **NSF/ANSI 140 Sustainability Assessment for Carpet** at its **Platinum level**. Carpet purchase shall require proof of independent third-party certification as specified in the Assessment.

#### **Affected entities are encouraged to:**

- Select carpet products that prolong the useful life of the carpet and reduce waste generation:
  - Select hard-backed carpet tile rather than broadloom carpet to permit replacement of individual tiles when damaged.
  - Select durable products, like “loop-pile”.
    - “Cut-pile” is not recommended for commercial or heavy-traffic areas.
- Reuse carpet, and recycle removed and replaced carpet whenever possible:
  - Include a take-back agreement from the manufacturer in the procurement of new carpet.
  - Work with the contractor during the purchasing process to look at available trade-in, reuse, donation and

- recycling options for used broadloom carpet and carpet tile, regardless of manufacturer.
- Contractors are encouraged to offer programs that include take-back, trade-in and the proper environmental disposal of materials (including carpet or tile sold by others).

### **Packaging**

Packaging shall comply with Environmental Conservation Law section 37-0205. Packaging shall not contain inks, dyes, pigments, adhesives, stabilizers, or any other additives to which any lead, cadmium, mercury, or hexavalent chromium is intentionally added or contain incidental concentrations of lead, cadmium, mercury, or hexavalent chromium which together are greater than 100 parts per million by weight (0.01%).

New York State encourages affected entities to adopt the following:

- The use of bulk packaging.
- The use of reusable packaging.
- The use of innovative packaging that reduces the weight of packaging, reduces packaging waste, or utilizes packaging that is a component of the product.
- That all packaging remain the property of the supplier and not become the property of the affected state entity under any circumstance or condition. The vendor shall certify that the packaging material will be reused, recycled, or composted, and managed in compliance with applicable local, state, and federal laws.
- Packaging that maximizes recycled content and/or meets or exceeds the minimum post-consumer content level for packaging in the U.S. Environmental Protection Agency Comprehensive Procurement Guidelines.
- Packaging that is recyclable or compostable.

### **Contracting:**

When and if the Office of General Services issues a new statewide contract for carpet and carpet tile, it shall issue a contract or an alternate contract for carpet and carpet tile that contain no PVC or PFCs and ensures that commodities purchased pursuant to the contract are reused and recycled to the maximum

extent practicable through take-back agreements with manufacturers or contractors or similar mechanisms.

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<sup>i</sup> Lang JR, Allred BM, Peaslee GF, Field JA, Barlaz MA, “Release of Per- and Polyfluoroalkyl Substances (PFASs) from Carpet and Clothing in Model Anaerobic Landfill Reactors,” Environ. Sci. Technol., May 2016.