Beneficial Use Potential of Vinyl Flooring in New York City

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Introduction

Vinyl flooring, also known as polyvinyl chloride (PVC) flooring, is highly prevalent in NYC, specifically in older buildings that make use of the material. There is a growing need to recycle or reuse existing vinyl flooring materials due to the discontinuation of phthalates in vinyl flooring in NYC. Due to NYC law, vinyl flooring enters the demolition waste stream through selective interior demolition. There are also other possible ways for PVC to enter the waste stream, such as building renovations, after a new tenant moves in, or even office to apartment conversions. NYC does not allow vinyl flooring with phthalates and other carcinogenic substances to be used in government facilities.

One mention of PVC used in public infrastructure is an introduction of a resolution where the NYC Council called upon the School Construction Authority to not procure any polyvinyl chloride products, mentioning vinyl flooring for use in NYC public schools. Unfortunately, this resolution was not passed, but this shows that there is an acknowledgement of the issues of using PVC flooring in public spaces (Granicus, Inc., n.d.).

PVC flooring waste is viewed as dangerous; however, there are ways to mitigate that danger by utilizing various different reuse and recycling tactics.

NYC and NYS Waste and Recycling Estimates for PVC Flooring/Plastic

Despite the burgeoning push to recycle vinyl flooring in its post-consumer state in New York City or New York State as a whole, no publicly available estimates or ranges provide guidance toward this objective. Rather, specific categories, such as PVC flooring, are amalgamated into C&D estimates for waste holistically. However, the New York Department of Sanitation's 2023-2024 Solid Waste Management Plan (SWMP) reports an estimated 2.1 million tons annually of C&D materials (DSNY, 2025). Furthermore, the Department of Environmental

Conversation estimated 18.4 million tons of C&D generated waste in the year 2018, with plastics comprising 1% of the total in NYS (DEC, 2023). Assuming plastics form 1% of C&D plastic waste in NYC as well, and that 2.1 million tons for NYC serves as a cap for total waste the following calculations can be made:

Category	Calculation
NYC Plastic C&D Waste Estimate	2.1M tons C&D waste × 1% plastic ≈ ≤ 21,000 tons/year

Table 1: NYC C&D Plastic Waste Estimate Calculation

Given a specific proportion or percentage of vinyl waste, *v*, calculated out of the above estimates for general plastic waste, the total of PVC waste can be expressed as 21,000*v*.

Considering that 6% of plastic waste production in the United States as a whole is attributed to PVC, and that 69% of PVC is used in the construction sector, a rough estimate for PVC C&D waste (not yet including specifically PVC flooring) can be calculated below, assuming these percentages hold true for NYC as well:

Category	Calculation
NYC Total PVC Waste Estimate	21,000 tons/year × 6% PVC waste ≈≤1,260 tons/yr PVC waste
NYC PVC C&D Waste Estimate	1,260 tons/yr PVC waste × 69% PVC C&D waste = 869.4 tons/yr PVC C&D waste

Table 2: NYC C&D PVC Plastic Waste Estimate Calculation

This value, 869.4 tons, serves as a rough, albeit erroneous estimate for C&D PVC plastic waste in the absence of solidifying data. Acknowledging that the amount of vinyl flooring is less than this approximation, if an arbitrary percentage of ~5% of PVC production can be traced to vinyl flooring for example, then this number would fall around ~43.47 tons/year of PVC flooring contributing to C&D waste. However, this number is highly disputable given that this may not truthfully encompass the national or city-wide averages for vinyl flooring C&D waste contributions.

Material Properties Summary

Flexible, plasticizer-treated PVC plastic, typically utilized in PVC flooring, possesses physical qualities indicated in the table below:

Property	Implication (Physical/Recyclability)
Oil Resistance	Resistance to oil, grease, in addition to like impurities, prevents structural and visual damage to flooring.
	PVC flooring may preserve its integrity for preprocessing and post-consumer activity due to the null effect of oils.
Durability	In the presence of standard conditions, vinyl flooring may last upwards of 20 years. Scratches, dents, and other indicators of deterioration are less improbable even in high-traffic areas.
	Mechanical processes for recycling require more input before PVC flooring material gives and changes into the desired form.
Fire Retardance	Flame-retardant chemicals make PVC flooring a more suitable choice in areas with electrical wiring and other common sources of fires, such as kitchens. (Housing News Desk, 2023)
	Recycling procedures that involve heating in any form may require higher temperatures to form PVC flooring into post-consumer product.
Processability	High processability in PVC allows for products to have excellent exterior surfaces and highly accurate molded dimensions.
	Due to the simpler formation of PVC plastic into its more complete form of vinyl flooring, the latter can be processed into smaller particles post-use to form new, post-consumer products by purely mechanical means.

	However, mechanical processing may require additional effort.
Malleability	The addition of plasticizers allows PVCs their malleable behavior. Post-consumer products do not deform as easily as their contemporaries.
	Due to plasticizers, some which may be phthalates, only chemical processes can be used.

Table 3: Physical Properties of PVC Plastic with Their Respective Implications (ECVM, 2019)

Furthermore, PVC plastic can be identified as a synthetic polymer composed of vinyl chloride monomers by means of polymerization. Due to the inherent rigidity of PVC plastic by itself, it requires the addition of plasticizers – such as phthalates and adipates – to increase flexibility to mold rigid PVC plastic into the more processable vinyl flooring used in residential and industrial settings. In the form of PVC plastic, vinyl flooring holds the following chemical properties and adheres to the indicated implications:

Property	Implication (Chemical/Recyclability)
Acid and Alkali-Resistant	Exposure to corrosive substances, both acidic and basic, are met without degradation of strength or significant chemical/visual compromise. (PVC's physical properties, n.d.)
	Many solvents used to separate polymers from each other may not be accessible for PVC products.
Soluble in Aromatic Hydrocarbons, Ketones, Cyclic Ethers	Exposure to these compounds causes swelling and softening in PVC. (ECVM, 2019)
	Similar effects to heating up PVC. May help with the pyrolysis process and formation of post-consumer products.
Insoluble in Organic Solvents	PVC plastic does not easily dissolve or soften, contributing to its durability when coming into contact with organic solvents.
	Many solvents used to separate polymers from each other may not be accessible for PVC products.

Resistant to Change in Molecular Structure	PVC's molecular structure makes chemical reactions with other substances less probable. (NYS OGS, 2022)
	Physical options may be preferable when considering the recycling process.
Bonded on a Hydrogen Polymer	Intramolecular strength is developed through internal bonds, causing external chemical interference to be lessened in impact. (Chemical resistance of PVC tiles: Applications and advantage, n.d.)
	High intramolecular strength may impede the process of pyrolysis. Higher temperatures will be needed to break the internal bonds.
Chlorinated	Higher chlorination levels (ranging from 25-60%) in PVC increase flexibility, as seen in durable, yet malleable PVC flooring. Oil resistance, air permeability, flame retardancy, and compression. (Kanade, 2024)
	An increase in both oil resistance and flame retardancy could lead to PVC flooring preserving its integrity for preprocessing and post-consumer activity due to the null effect of oils and may require higher temperatures to form PVC flooring into post-consumer product.
Halogenated	Halogenated polymers contribute tensile strength, heat resistance, low conductivity, flame retardancy, liquid repellence, and chemical and weather resistance. (Shafi Kuttiyathil & Altarawneh, 2025)
	Contributing heat resistance may impede the pyrolysis process, stopping the formation of the post-consumer product.

Table 4: Chemical Properties of PVC Plastic with Their Respective Implications

Known morphological characteristics for flexible PVC plastic, derived from testing are recorded below:

Property	Value
Density	85 lb/ft^3
Poisson's Ratio	0.39
Specific Gravity	1.37

Tensile Strength, Ultimate	~110 – 22,600 psi
Tensile Strength, Yield	~ 17.5 – 7,250 psi
Elongation at Break/Yield	16 – 700%
Young's Modulus	~200 ksi
Modulus of Elasticity	0.801 – 469 ksi
Flexural Modulus	10.9 – 435 ksi

Table 5: Mechanical Properties of Flexible Plasticizer-Treated PVC in Imperial Units (lb, psi, ksi, ft)[1,2,3]

This data corresponds to flexible, plasticizer-treated PVC, typically found in the more malleable PVC flooring (as opposed its rigid counterpart, PVC pipes), as well as household items, such as credit cards, garden hose, plastic bottles, office equipment, and film or fabric coatings, to name a few applications (Inplex Custom Extruders, LLC, 2025). PVC flooring is most often recycled or reused in its post-consumer form. When PVC flooring is removed, the recovered material is usually in the form of torn sheets or broken tiles, with adhesive (in the form of glues or magnetic components) present on most pieces, necessitating the separation of excess adhesive in the recycling process. In preparation for recycling, PVC flooring is usually degraded into strips or ground down into smaller particles (of varying particle diameters) depending on the selected means of recycling.

While the American Society for Testing and Materials (ASTM) has not provided standards regarding the recycling of PVC flooring, they have established definitions for material classification, and regulations for the use of PVC flooring with and without backing, where PVC backing is the protective layer conducive to waterproof, structural and protective properties, improving the quality and aesthetic of flooring (Long, 2020). Namely, ASTM F 1303 in Volume 15.04 of the Book of Standards maps out the specifications for sheet vinyl floor coverings with

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[1] *Thermoplastic*. MakeItFrom.com, 2020
[2] Inplex Custom Extruders, LLC, 2025
[3] Overview of materials for PVC, rigid grade, n.d.

backing (fibrous, non-foamed or foamed plastic), stating that PVC flooring with backing is to be used in “commercial, light commercial and residential building” based on their abilities to provide suitable service to these respective locations. Below is an abbreviated table of requirements for Type I (90% minimum PVC flooring wear layer for protection) and Type II (34% minimum) PVC flooring products with protective backing:

Characteristics	**Type I Products**	**Type I Products**
Wear Layer Composition	90% minimum binder content	34% minimum binder content
Overall Thickness	0.040 in. (1.0 mm) minimum	0.040 in. (1.0 mm) minimum
Residual Indentation (after 1 hour recovery)	<0.012 in. (0.31 mm) 50 lb load on a 3/4” diameter ball tip for 5 min.	<0.007 in. (0.18 mm) 75 lb load on a 1/4” diameter flat tip for 15 min
Flexibility	¼” (6.4 mm) diameter mandrel – no cracks or breaks	1 ½” (38 mm) diameter mandrel – no cracks or breaks
Static Load	Residential: 75 psi/0.005” (0.13 mm)	
	Light Commercial: 125 psi/0.005” (0.13 mm)	
	Commercial: 175 psi/0.005” (0.13 mm)	

Table 6: Excerpt from Protection Layer Requirements for PVC Flooring with Backing (AHF, 2023)

Requirements for chemical, heat, and light resistance are included in the documentation in addition to the metrics above. The regulatory document, while explicitly stating that it does not encompass all possible safety hazards of PVC flooring, entrusts the user to ensure proper use of flooring, adhering to all applicable safety, health and environmental policies that are in place at the location of usage (ASTM, 2021). On the other hand, ASTM F 1913 reviews regulation for sheet vinyl flooring covering without backing, authorized for use in commercial and light commercial buildings. For this category of PVC flooring, the binder content, including “vinyl resins, plasticizers, and stabilizers," is a minimum of 50% (ASTM, 2025). Below is the excerpted version of the requirements for PVC flooring products without protective backing:

Characteristics	Type I Products
Wear Layer Composition	50% minimum binder content
Clear Specialty Top Layer	0.0004" (0.01 mm) minimum 0.005" (0.137 mm) maximum
Overall Thickness	0.075 in. (1.9 mm) minimum
Residual Indentation (after 1 hour recovery)	≤ 0.007 in. (0.18 mm) 75 lb load on a 1/4" diameter flat tip for 15 min.
Static Load Resistance	≤ 0.005 in. (0.13 mm) residual indentation at 250 psi
Flexibility	1 ½" (38 mm) diameter mandrel – no cracks or breaks

Table 7: Excerpt from Protection Layer Requirements for PVC Flooring Without Backing (AHF, 2023)

Akin to the regulations for PVC flooring with backing, further specifications for chemical, heat, and light resistance are stated in the document.

The most prominent health hazard of PVC flooring is the emission of di-ethylhexyl phthalate (DEHP). DEHP production stems from the equilibrium between the material and gas phase, external mass transfer (the movement of a substance from fluid to the surface of a solid), and strong partitioning to interior surfaces. In a study conducted in 2015, air samples from children's bedrooms were extracted, as well as urine samples during a two-week period. It was found that rooms with carpet or word, as opposed to vinyl flooring, had less concentrations of the DEHP compound (Just et al., 2015). Another case study, also involving samples taken from bedrooms with various types of flooring, but with the incorporation of phthalate-based plasticizers, drew a similar conclusion: the room with vinyl flooring reached a steady concentration of DEHP within one year, while the non-vinyl flooring spaces reached the same concentration three months later (Xu et al., 2009). Across various studies, DEHP emissions were conducive to respiratory difficulties – such as asthma, rhinitis, and wheezing – as well as reproductive disorders and the imbalance of endogenous hormones.

The resilient chemical and molecular structure of PVC plastic poses challenges to its environmental impact, more so than it holds prominence in the health scene. In the environmental scope, a study ranked three different flooring types – linoleum, vinyl flooring, and solid wood flooring – based on resource, energy, emission and waste generation use per function unit flooring material. Out of the three types, wood flooring was found to be the most environmentally friendly, whereas vinyl flooring was discovered to have the most hazardous impact on environmental health (Jönsson et al., 1997). Specifically, the presence of volatile and semi-volatile organic compounds poses threats not during use, that is, through health impacts on individuals in spaces where vinyl flooring is installed, but rather during installation and the early stages of use, its pre-consumer state, and when it is left in landfills, unpurposed after removal, its post-consumer state. Since vinyl flooring is non-biodegradable, discarded scraps accumulate in landfills, resulting in prolonged environmental damage. When post-consumer PVC plastic is left unutilized, phthalates used to soften rigid PVC may seep into water sources, causing chemical contamination to drinking water or aquatic habitats, as well as plastic decomposition, engendering the dispersion of microplastics into surrounding areas (Forté, 2025). Alternatively, a common technique of incineration is used to reduce plastic volume, releasing energy that can be converted into heat or electricity. However, this method produces greenhouse gases and fumes that contribute to the compromise of atmospheric conditions and the ozone layer (Lu et al., 2023).

Beneficial Use Options

Pyrolysis

(a) Pyrolysis is the slow heating of scrap PVC materials with carcinogenic chemicals such as phthalates and then capturing useful chemicals to be made into other products.
(b) The process used in an experiment is the grounding down of vinyl panels taken directly from a residential building, with no testing required.
(c) The key benefits are that it allows industries to take advantage of building renovations, by removing any impurities and recapturing compounds which would allow the creation of newer cleaner products, instead of having to produce these chemicals. For example, our source found that pyrolysis produced more sources of ion current density than for combustion, which means that there are more chemicals available for capture to be used in new products (Kajda-Szcześniak & Czop, 2022).
(d) The biggest limitation would be the fact that it is unknown about the technological developments or equipment necessary to scale, since the research only used a small sample, and it is unknown whether this could be made into an industrial process.

Light Concrete

(a) The use of crushed PVC materials in concrete, acting as a portion of the fine aggregates.
(b) Preprocessing required is the crushing of PVC materials. This saves cost of insulation in buildings, by reducing the required insulation and in the cost of concrete since it does not need specialized, more expensive fine aggregates. There does not seem to be a major limitation in this method, but more research is needed on the possible seeping of harmful chemicals from the PVC into the air.
(c) It was found that it reduced the specific mass of concrete, and it significantly reduced the transmission of sound impact through the concrete. In fact, all concrete blocks tested containing PVC as a portion of find aggregate led to a higher reduction of sound levels in

frequencies from 630Hz. There was also observed a correlation between specific mass and impact sound, with total replacement of coarse aggregates and partial replacement of fine aggregates performing the best acoustically (Pacheco et al., 2017).

(d) In early stages of implementation, the process uses newer PVC without harmful chemicals. But otherwise, the infrastructure required to create this concrete already exists. Crushing the PVC is not too difficult, and concrete plants already can perform the process needed to crush materials for aggregates.

Mechanical-Based Recycling

(a) Mechanical-based recycling involves the melting down of old PVC.

(b) Since this is a purely physical process, it cannot remove chemical impurities. Thus, it must be checked to ensure it is of good quality before melting.

(c) The remelting of old PVC allows reformation into other undemanding products, such as lampposts or garbage cans, or even wood substitutes in construction. The benefits would be the establishment of a circular economy in PVC, reducing waste and overall cost of production, since new PVC would be more expensive than cleaning contaminated PVC (Mangold & Von Vacano, 2022).

(d) Some limitations are the need for testing PVC waste to ensure that any contaminated PVC is cleaned before it is melted, which would require additional steps to the manufacturing process. Investments would be necessary to expand this testing facility to an industrial scale.

Solvent-Based Recycling

(a) Solvent-based recycling is another option to recycle PVC. In solvent-based recycling, there is a target polymer, and other polymers and impurities are separated from the target polymer. Then the target polymer is used to create new products.

(b) The target polymer is dissolved in a specific solvent, and insoluble impurities, additives, and other polymers are separated through mechanical recycling, usually filtration. The purified polymer is recovered from the solvent by precipitation, which involves either using an anti-solvent, fast solvent evaporation, or cooling down. There is a high energy cost associated with solvent recovery and complete solvent removal from the target polymer (Mangold & Von Vacano, 2022).

(c) This process maintains the properties of the non-recycled product. This also leads to the elimination of hazardous additives and deteriorated properties.

(d) The amount of solvent used in the process must be minimized because it might lead to increased carbon dioxide emissions. This process is also very energy-intensive, and the chemicals used in the process of cleansing may be toxic. This method is limited by the recycled product’s slightly lower molecular weight, and the effects of this must be studied (Mangold & Von Vacano, 2022).

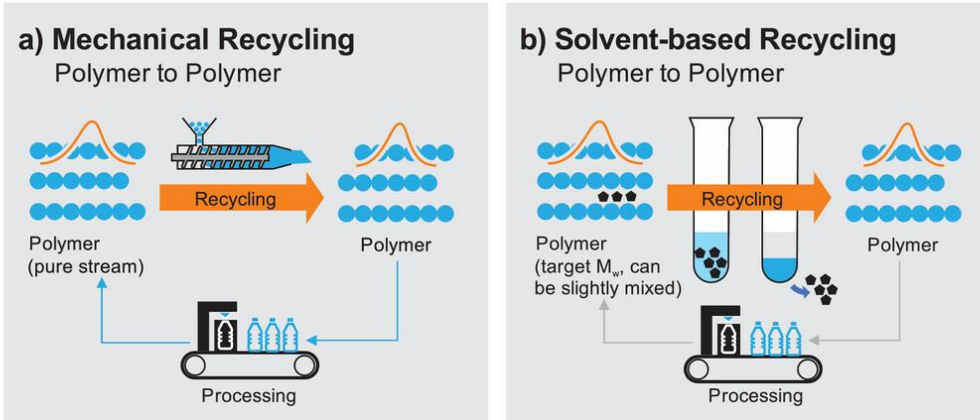

Figure 2: Mechanical and Solvent-Based Recycling for the PVC Polymer (Mangold & Von Vacano, 2022)

Repurposing Post-Consumer Waste for New PVC Flooring

(a) European PVC flooring manufacturers have established the Association for the Recycling of PVC Floor-Coverings (AgPR), where they have implemented a process of collection, sorting, cleaning, and decomposition. The final product is PVC pellets, made from used PVC flooring (Goedecke, 2016).

(b) Prior to the recycling process, PVC waste is separated from non-PVC materials. A shredder mechanically breaks the PVC down into smaller chips, their sizes averaging about 3 cm across. Magnets are incorporated to extract foreign metals in the mix.

(c) Due to the expenditure of PVC in the oil industry, and the environmental repercussions of producing the polymer, reduction in production and making use of existing or post-consumer PVC is the preferred path. Due to the cost-efficiency of simply producing new PVC, and its ubiquity in its applications such as medical supplies, plastic containers in any capacity, and plumbing, solely depending on recycling in this fashion for PVC production is unsustainable economically.

(d) There are concerns about the long-term quality of perpetually recycled PVC and possible degradation concerns, and these should be addressed through more research. However, an interim solution could be the use in less demanding applications.

Figure 3: PVC Chip (30mm) and Finely-Ground Particle (<0.4mm) Processing (Goedecke, 2016)

NYC and NYS-Specific Context

New York City and New York State both have specific regulations and laws around PVC flooring. Under Executive Order 4, the New York State Office of General Services (NYS OGS) issued a couple of specifications regarding floor coverings. Those specifications involved stating that carpet and other floor coverings, including PVC flooring, which emit VOCs and SVOCs. Phthalates were used as plasticizers in PVC flooring but were then replaced by VOCs and dioctyl terephthalate (DOTP). The definition of resilient flooring includes PVC flooring, which is further defined as non-textile flooring produced in the form of tiles and sheets. All entities involved in procuring flooring should attempt to limit all PVC and recycled PVC. Chlorinated materials, which involve PVC, should not be intentionally added. The final specification was that if the NYSOGS issued a new contract regarding flooring, there would be an additional clause for carpet/carpet tiles devoid of PVC or perfluorinated chemicals (PFCs) (NYS OGS, 2022).

According to the New York City Housing Authority (NYCHA) Design Guidelines, the use of vinyl finishes (which include PVCs and any other petrochemical vinyl) is prohibited (NYCHA, 2025). The NYC Department of Sanitation recommends vinyl and laminate flooring, and tiles should be disposed of as trash (NYS DSNY, n.d.).

In 2023, the New York Senate passed a bill known as NY S00834, which referred to the carpet collection program. The bill mandated carpet manufacturers to fund the collection, transportation, reuse, recycling, and proper end-of-life management of carpets across the state. These manufacturers would be involved in managing PVC carpeting as well.

There are no beneficial reuse options specifically for PVC in the NYSDEC Part 360; however, there is a way for case-specific beneficial use of determinations to be stated. The company must submit a written petition to the department describing the waste and its properties, where it came from, justification for its use and low environmental impact, a contract for the use of the waste, and a plan for storage and implementation.

According to the New York State Department of Environmental Conservation Division of Materials Management, Use of Predetermined Beneficial Use Determination document, certain excluded hazardous waste can be reclaimed, recycled, or reused.

NYC Pilot Projects/Efforts

Big Reuse, a NYC non-profit which focuses on decreasing the amount of waste, has worked with the DSNY, and received funding from the City Council. Under the NYC Smart City Testbed, there was the Clean Construction Innovation Pilot, which focuses on construction companies making their processes as clean as possible. There is room for including new waste streams, specifically PVC flooring, in future iterations of the program. The Vinyl Institute's VIABILITY program allocates grants to advance PVC recycling and repurposing.

NYC Infrastructure/Storage/Permitting Constraints

NYC is restricted by its industrial and waste management footprint. There is limited space for waste processing facilities, meaning that many of the proposals made will likely be made outside of the five boroughs. This is a constraint for the infrastructure needed to sort and process nontraditional streams like vinyl. There is also a lack of construction and debris vinyl recycling stream, because it does not fit into any mandated recycling category, so there are no curbside routes, private carting haulers and transfer stations treat it as residual waste for a landfill or incineration, and special handling or sorting of mixed C&D waste is limited.

NYC Incentive/Barriers

DSNY and planning documents emphasize growing reuse networks are evidenced by their partnerships with donateNYC and Big Reuse and other non-profits. Funding opportunities, either from grants or city support, favor the circular economy and reuse infrastructure. Industry grants for recycling startup infrastructure such as VIABILITY create potential funds that local recyclers or nonprofits could tap into. Some barriers are that DSNY does not currently view vinyl flooring as a recyclable material, but disposable waste; PVC recyling is less economically attractive than common plastics, and there are not many dedicated drop-off or sorting facilities in NYC that accept vinyl flooring.

Conclusion

(1) The beneficial strategies that appear to be the most viable in NYC are reusing contents that contain PVC and the use of pyrolysis. PVCs may contain dangerous chemicals which slowly emit in homes over time. If we need to clean PVCs that contain these chemicals, we will have to use a cleaning process such as pyrolysis. This could feasibly be added to

current facilities in the NYC area, since there are multiple locations, and they are already in areas that are far from residential areas, so environmental impact from pyrolysis would be mitigated. These facilities also most likely already have licenses for combustion of waste. Chemicals harvested from this would be turned into new products. Vinyl flooring without the dangerous chemicals within the PVC should be cleaned and grounded up into small pieces, as our 5th re-use proposal describes. This would be the process for newer PVCs without dangerous chemicals.

(2) The challenge would be to test this on a commercial scale before full implementation, as more research would be required. A pilot program could be installed, and this would allow the city to recycle both old PVC with harmful chemicals and newer PVC without these chemicals but too damaged to be reused as is. Additionally, due to the lack of data pertaining to PVC wastage and vinyl flooring waste specifically, it is difficult to determine the impact of vinyl flooring waste in NYC. Intentional logging of vinyl flooring use, waste, and recycling rates will be useful to guide beneficial use of the prominent construction material for future endeavors.

(3) Different recycling options are viable for different types of PVC flooring. PVC flooring possesses a variety of material properties, and those different properties determine what recycling processes fit best. An example would be that a chemical property of PVC plastic is that it is resistant to change in molecular structure. That property makes chemical processes less viable than mechanical properties, because it would take more resources to perform pyrolysis, where the PVC would be heated to the point that the bonds between the molecules would break, or solvent based reycling, where polymers

would be separated through dissolution. The viability of reusing and recycling PVC flooring depends on various factors.

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