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Beneficial Use Potential of Construction Plastic in NYC

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Introduction/Scope Of Study

This article investigates construction plastics—specifically polyvinyl chloride (PVC) and high-density polyethylene (HDPE)—as materials present in New York City's construction and demolition (C&D) waste stream. These thermoplastic polymers are used in NYC's built environment. This is because of their durability, resistance to moisture and chemicals, and long service life. However, they also result in persistent waste streams when reuse or recycling pathways are not implemented at end-of-life.

Vertical Construction Applications (NYC-Specific)

In New York City's vertical construction sector, PVC and HDPE are most commonly found in high-rise residential and commercial buildings, particularly in Manhattan, Downtown Brooklyn, and Long Island City. Typical applications include PVC potable water piping, sanitary sewer lines, electrical conduit, and protective membranes used in apartment towers, office buildings, and mixed-use developments. Major sources of plastic waste arise during interior renovations, tenant fit-outs, and system upgrades in aging building stock, especially during plumbing replacement projects in pre-1980 buildings.

Horizontal Infrastructure Applications (NYC-Specific)

In horizontal infrastructure, PVC and HDPE are widely used in buried and exposed municipal systems. NYC agencies such as the Department of Environmental Protection (DEP) and Department of Transportation (DOT) utilize HDPE and PVC for stormwater drainage pipes, sewer liners, water distribution mains, and utility conduits. These plastics enter the waste stream during street reconstruction projects, sewer rehabilitation, and utility replacement work, which occur continuously across the five boroughs.

Waste Generation Context

Both selective interior demolition and full-building demolition generate PVC and HDPE waste. Selective demolition often produces fragmented and contaminated plastics, while full demolition can yield larger plastic components that are frequently mixed with general debris unless source separation occurs. Given the pace of NYC renovation and infrastructure renewal, these activities create recurring streams of plastic waste with potential for recovery and beneficial reuse.

Regulatory Context

Construction plastics in New York State are regulated under NYSDEC Part 360 Solid Waste Management regulations, which define whether materials are considered solid waste or may be reused under a Beneficial Use Determination (BUD). The availability of predetermined or case-specific BUDs strongly influences whether recovered PVC and HDPE can be processed or reused without additional permitting, directly affecting feasibility within NYC construction projects.

Estimated Annual Quantity of PVC and HDPE in NYC C&D Waste IIIIIIIIII

Although construction plastics represent a relatively small fraction of New York City's total C&D waste by weight, their absolute quantity remains significant due to the scale of construction activity. NYC generates approximately 14–16 million tons of C&D debris annually, based on city and state solid waste reports. Plastics typically account for 1–3% by weight of C&D waste streams, with PVC and HDPE comprising the dominant polymer types used in construction applications.

Using a conservative estimate of 1–2% plastic content, the annual quantity of construction plastics generated in NYC can be approximated as 140,000–320,000 tons per year. Of this total, PVC and HDPE are estimated to represent 60–70%, based on their prevalence in plumbing and infrastructure systems. This yields an estimated 85,000–220,000 tons per year of PVC and HDPE entering NYC's C&D waste stream.

These estimates are derived using (1) published NYC C&D tonnage data, (2) reported plastic fractions in demolition waste, and (3) known material usage patterns in NYC buildings and infrastructure. While the exact quantity varies annually with construction activity, this range demonstrates that even modest recovery rates could divert substantial volumes of plastic from landfills.

Material Property Summary

PVC and HDPE are both thermoplastic polymers, with specific physical, chemical and morphological properties which directly affect their engineering applications in construction as well as their potential beneficial reuse. PVC is an amorphous polymer made up of vinyl chloride monomers and typically contains stabilizers, plasticizers, and fillers. Such additives are responsible for PVC's high resistance to water, chemicals and weathering, but they also make recycling more challenging since thermal treatment can lead to formation of hydrochloric acid or decomposition of stabilizing compounds when not controlled. On the other hand, HDPE is a partial crystalline polyolefin that is made up of carbon and hydrogen making it have high tensile strength with low specific gravity and very low water absorption. Experimental data for HDPE pipes show density around 950 kg/m^3, elastic moduli from 1–1.3 GPa and strain at break larger than 400% and water absorption lower than 0.1%, which justify its wide use in pressurized as well as embedded pipe systems.

in degradation Both materials are impervious to biological attack and moisture absorption, but they degrade differently under both heat and ultraviolet exposure. PVC is vulnerable to dehydrochlorination at high temperatures, which can cause discoloration and embrittlement when stabilizers are deficient. HDPE degrades thermally more slowly and is more suitable for mechanical recycling of closed loop recycling systems imposing greater difficulty during processing.

In the demolition case, PVC and HDPE are generally collected in an end-of-life condition or as part of mixed/dirty monostreams. Typical recovered forms are pipe sections, roofing sheet, liner and mixed plastic scrap as a result of plumbing removals, service upgrades and full building demolitions. Such materials are often mixed with other construction refuse, and therefore further contaminated with adhesives, coatings or installed items that the plastic may come in contact with. Bigger, less contaminated HDPE items (for example, pipe sections) tend to have higher reuse potential than small mixed fragments because PVC reclamation often involves further sorting and chemical treatment to account for additive content.

There are a number of engineering standards that one has to pay attention to when considering the recycling and re-use of plastics in construction. The mechanical properties and material categorization of recycled plastics have been generally tested and characterized by the ASTM tensile, flexural behaviors, water absorption tests (ASTM D638, C78 and D570 etc.,) which are also widely used in plastic composites or modified construction materials. For indirect reuse, such as in pavement base or subbase materials, generalized ASTM and AASHTO standards (ASTM D1557 and D1883, AASHTO T307) are employed to assess the stiffness (resilient modulus) and bearing capacity of plastic-modified aggregates. Adherence to these standards is important for acceptance pursuant to NYSDEC Part 360 beneficial use pathways and being considered for incorporation into NYC infrastructure projects.

Environmental issues Health and environmental concerns vary between PVC and HDPE. PVC particularly has been a subject of concern because of its chlorine content and compounding agents that can form harmful byproducts when improperly thermally recycled, as well as potential occupational exposure during uncontrolled processing. HDPE does not include halogens or plasticizers, therefore it represents a low risk during mechanical recycling with reduced emissions and toxic byproducts generated from reprocessing. Life cycle assessments demonstrate that recycling building plastics, especially HDPE and soundly managed PVC, is far better for the environment than virgin resin manufacture and thereby supports environmental considerations of established controlled reuse and recycling routes.

Key Properties and Reuse Implications

Property	**PVC**	**HDPE**	**Relevance to Beneficial Use**
Density	~1,400 kg/m³	~950 kg/m³	Affects transport cost and volume-based recovery
Water absorption	Very low	Very low	Suitable for wet and buried applications
Tensile behavior	Stiff, brittle without plasticizers	Ductile, high elongation	HDPE better for mechanical recycling
Thermal stability	Sensitive to high temperatures	Thermally stable	Limits PVC processing routes
Chemical composition	Contains chlorine & additives	Hydrocarbon-only	HDPE has lower environmental risk

Property	**Why It Matters for Reuse**	**Affected Beneficial Reuse Pathways**
Density	Influences transportation efficiency, stockpiling volume, and economic feasibility of recovery	Aggregate replacement, lightweight fill, composite products

Water absorption	Low absorption ensures durability in wet, buried, or subgrade environments	Pavement base/subbase, drainage layers, pipe reuse
Tensile behavior	Determines mechanical performance under load and suitability for mechanical reprocessing	Plastic lumber, molded construction products, pipe reuse
Ductility / elongation	High ductility improves resistance to cracking and processing damage	Mechanical recycling, composite reinforcement
Thermal stability	Governs allowable processing temperatures and limits reuse options	Mechanical recycling (HDPE), restricted thermal reuse (PVC)
Chemical composition	Additives and halogens affect environmental risk and regulatory acceptance	NYSDEC Part 360 BUD approval, infrastructure applications
Contamination tolerance	Determines need for sorting, cleaning, or preprocessing	Direct reuse vs. downcycled applications

Recovered Material Condition

In demolition scenarios, PVC and HDPE are typically recovered as pipe sections, liners, membranes, or mixed plastic scrap. These materials are frequently contaminated with adhesives, coatings, or embedded hardware. Larger, source-separated HDPE components generally exhibit higher reuse potential than fragmented PVC due to reduced additive complexity.

Testing Standards Relevant to Reuse

Beneficial reuse pathways rely on established engineering standards to ensure performance and regulatory compliance. Commonly applied tests include:

- ASTM D638 – Tensile properties of plastics (relevant to remanufactured plastic products and pipe reuse)
- ASTM D790 – Flexural properties of plastics (relevant to plastic lumber and structural plastic components)
- ASTM D570 – Water absorption of plastics (relevant to buried and wet-environment applications)
- ASTM D1557 – Compaction characteristics of plastic-modified aggregates (relevant to pavement base and subbase reuse)
- ASTM D1883 – California Bearing Ratio for bearing capacity of plastic-modified materials
- AASHTO T307 – Resilient modulus for pavement design and acceptance

Adherence to these standards is critical for acceptance under NYSDEC Part 360 BUD pathways and for incorporation into NYC construction and infrastructure projects.

Environmental and Health Considerations

- PVC-specific risks: chlorine content, potential acid gas release during uncontrolled thermal processing
- HDPE-specific risks: minimal, no halogens or plasticizers
- Risk mitigation: controlled mechanical recycling, temperature regulation, emissions controls

Life-cycle assessments consistently show that controlled recycling of PVC and HDPE yields significantly lower environmental impacts than virgin resin production, supporting the environmental viability of beneficial reuse.

Beneficial Use Options (Literature-Based Review)

Plastic waste poses long-term environmental issues, whereas the construction industry has demonstrated possibilities of recycling plastics into long-lasting structural materials. This review of literature critiques five useful reuse plans and records a basic description and purpose. (b) required preprocessing or testing, benefits, limitations, and applicability according to NYSDEC Part 360 Beneficial Use Determinations (BUDs). Alignment with NYSDEC Part 360 Beneficial Use Determinations (BUDs) is noted for each strategy, along with evidence of current real-world use.

4.1 Recycling Plastic into New Construction Products

Recycling the plastic material into new construction products entails the transformation of post-consumer waste into other materials like structural lumber, decking planks, and outdoor boards. The method will help to avoid the use of landfills and decrease the reliance on natural resources like hardwood. The strategy is witnessed through the reconstruction of the Coney Island Boardwalk in New York City, where recycled plastic lumber was used, as it had much safer, stronger qualities and existed in an environmentally friendly manner (Tangent Materials 1).

Figure 1: Coney Island Boardwalk construction photo

The plastics are supposed to undergo sorting, cleaning, a shredding and pelletizing process, then again remanufactured into construction materials. Minde et al. state that the steps are critical in the homogeneous melt behaviour of the final product and adequate mechanical properties (3). Such tests are tensile strength (ASTM D638), flexural strength (ASTM D790), water absorption (ASTM D570), and compression testing (ASTM D695).

Plastic lumber that is recycled has high durability advantages. According to the case study of Coney Island, the old boardwalks that were constructed with domestic hardwood became warped, splintered and moulded within a number of years, but the recycled plastic lumber did not deteriorate structurally (Tangent Materials 2). This material did very well in Superstorm Sandy, with a projected service life of 50 or more years and a 75% reduction in maintenance costs in 20 years.

Despite all these good performances, PVC has a low heat deflection temperature (60-80 °C) and is more brittle than HDPE. HDPE contains a high level of thermal expansion (10-15 times that of wood) that needs expansion joints, reduced stiffness that needs extra support and the surface can be slippery in wet conditions. Neither of the materials is so fire-resistant, and it is possible to add a fire-retardant.

Important Pre-established Beneficial Use 6 NYCRR SS 360-1.15(b) 8. In the NYC Parks system, such as the Coney Island Boardwalk and waterfront installations, are also actively deployed.

4.2 Using Plastic as Aggregate in Concrete and Asphalt

The use of shredded plastic as a partial substitute for natural aggregates in concrete has been studied by scientists. Mohamedsalih et al. argue that in 2.5-5% replacement plastic aggregate, there can be viable lightweight concrete mixes (3). It targets the reduction of natural aggregate consumption and the rehabilitation of plastic waste out of landfills.

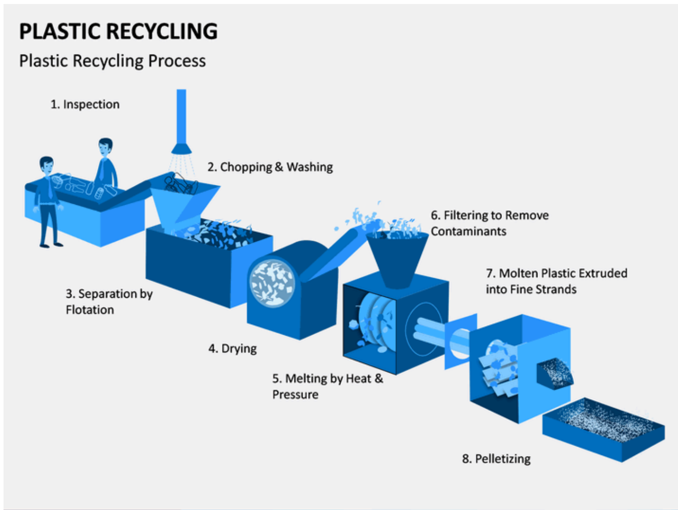

Figure 2 : Plastic Recycling Process

Aggregate production of plastics is carried out through cleaning, drying, sorting and shredding. Minde et al. give a sequence of actions scheme of incorporation to cementitious materials (4). Assays involve compressive strength (ASTM C39), density (ASTM C138), water absorption (ASTM C642) and slump test (ASTM C143).

The benefits include a reduction in the natural aggregate extraction and experimental concrete density. Mohamedsalih et al. observed the compressive strength reduction to be only 1% at 2.5% plastic replacement, that is, performance reduces unimportantly (6). Replacement of 12.5% decreased the density by 11%.

The hydrophobic properties of HDPE (angle of contact with water 94 °) lead to poor bonding of cement paste with other materials and a low interfacial transition zone. The elastic The modulus of PVC (2.4-4.1 GPa) is much less than that of natural aggregates (45-75 GPa). There was a 39 per cent decrease in compressive strength at 12.5 per cent replacement (Mohamedsalih et al. 7). Not sanctioned for structural use.

Case-Specific BUD Required. Experimental phase only; no active construction projects in New York State.

4.3 Manufacturing Lightweight Plastic Bricks or Blocks

These plastic bricks are produced by transforming disposable plastic into building blocks that can be connected. Yadav et al. note that plastic bricks may be called a new invention of the plastic waste problem and the ecological role of the construction process (1).

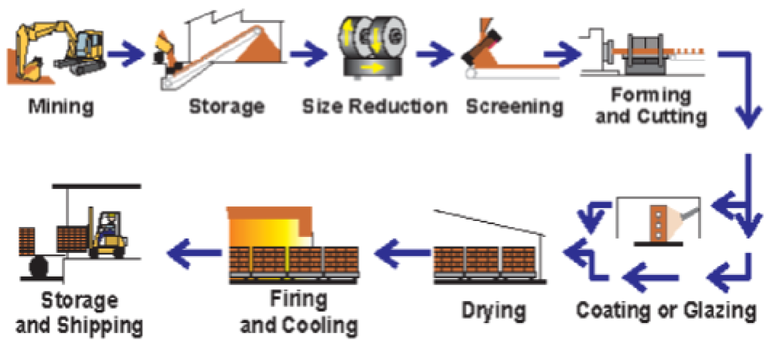

Figure 3 : Brick Manufacturing Process - mining through cooling

The manufacturing consists of sorting, cleaning plastic waste, shredding it and placing it through the process of melting it at 180-220 °C and compression molding it (Yadav et al. 4). Tests involve compressive (ASTM C67), water absorption (ASTM C67), thermal conductivity (ASTM C177) and fire resistance (ASTM E119).

Yadav et al. demonstrated that the compressive strength of plastic bricks is 5-50 % higher than that of clay bricks (5). They offer low water content, high thermal resistance and reduced carbon emission as the kiln firing is not used during production.

HDPE contains a flame spread index of 200-300, and melts at 130 °C. PVC emits gas of hydrochloric acid upon burning. The two are both characterized by deformation due to creep experienced under sustained loads, where HDPE cannot be used in load-borne walls beyond a height of 2 stories. When there are no stabilizers, the tensile strength is reduced by half after 2-3 years due to UV degradation. Lacking in building codes on structural uses.

Case-Specific BUD Required. Poor pilot projects; in New York, applications are small-scale, and there are limited pilot projects by companies such as ByFusion producing blocks.

4.4 Energy Recovery from Non-Recyclable Plastics

Waste-to-Energy (Waste to Energy Plants) involves the use of non-recyclable plastics as fuel to create electricity and heat. Themelis remarks that waste has a significant position in sustainable waste systems because it involves the usage of plastics, which cannot be recycled in a mechanical system (249).

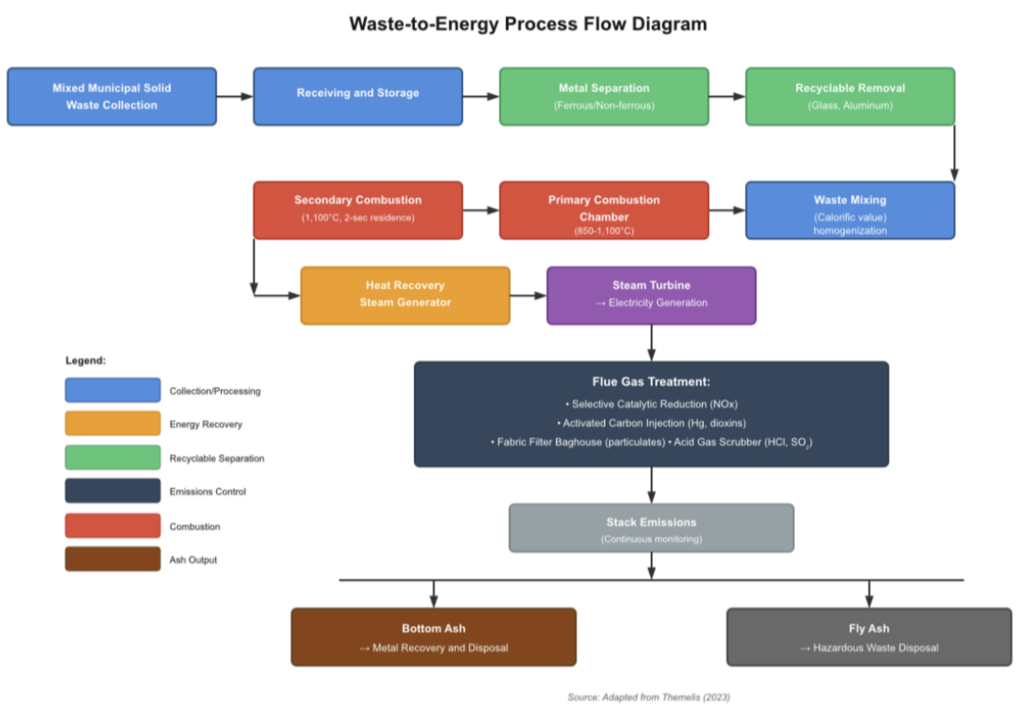

Figure 4: Waste-to-Energy Process

To ensure that the waste has a calorific value, waste disposal plants use metal separation, extracting waste that can be recycled, and mixing it with other waste. They undertake constant emission control to meet the environmental requirements (Themelis 251). The testing involves continuous emissions testing (NOx, SO 2, CO, HCl), TCLP testing on ash, and dioxin and mercury stack testing.

Themelis reports that MSW produces 0.55 MWh of electricity per ton (252). HDPE contains 43-46 MJ/kg of energy, whereas PVC contains 18-20 MJ/kg. Waste eliminates the effect of landfill gas emission, cuts unnecessary transfers of garbage over long distances, and recovers the bottom ash metallic contents.

The high chlorine content of PVC (56.7) creates HCl gas that necessitated an extensive process of acid gas scrubbing, which adds up to $15-25 per ton. The risk of formation of dioxin accelerates below 850 °C when it contains chlorine. Feeding problems occur because of the high melting point of HDPE. The two emit greenhouse gases (0.7-1.0 ton CO_2/ton MSW).

NOT a BUD pathway. Controlled by Part 360, Sub Part 360-3 (combustion facilities) and air quality permit (New York State Department of Environmental Conservation). Hempstead (2,250 tons/day, 60 MW), Covanta Onondaga (990 tons/day, 28 MW) and Covanta Niagara (750 tons/day, 20 MW) facilities all have a capacity of processing about 1.2 million tons every year.

4.5 Reuse of Plastics in Landscaping and Outdoor Infrastructure

This plan transforms used plastic into outdoor landscape materials such as outdoor park benches, picnic tables, fence posts, parking stops, landscape edging, and pavers. In contrast to the structural boardwalks and decking that are the subject of Section 4.1, this highlights site furniture and hardscape items that need to withstand the weather. The materials meet well at the locations where moisture resistance and wearability were important, and in direct contact with soil.

Figure 5: Outdoor deck/landscaping with recycled plastic

The preprocessing includes cleaning, reducing, pelletizing and mixing with UV stabilizers (2-5%). The report indicates that plastic boards undergoing recycling are suitable for high foot-traffic and coastal surroundings (Tangent Materials 2). Some of the tests used are UV weathering (ASTM G154), slip resistance (ASTM C1028), soil contact durability (ASTM G160), and low-temperature impact (ASTM D256).

Plastic materials that have been recycled are resistant to rot, moisture, corrosion and their service life is 25-40 years compared to 7- 12 years in treated wood. They can withstand 50 or more freeze-thaw cycles annually and have no deterioration due to road salt. Less Golden parachute, low cost saves 40- 50% lower lifecycle. All the park benches redirect 75-100 lbs of plastic waste.

Dark colors may get up to 65-75 °C during sunny days, which is also uncomfortable to touch. The thermal expansion is 5-8 times that of wood, which requires expansion gaps. The stiffness is 30-40 times less than wood, whose cross-sections become thicker. The colour loses 10-20% of colour in a period of 10 years. Patterned products cannot be easily reused at the end of life.

Predetermined Beneficial Use under 6 NYCRR § 360-1.15(b)(8) for source-separated recyclables (New York State Department of Environmental Conservation).

Current Use in New York. Implemented completely in NYC Parks and had 500-plus benches, 200-plus picnic tables, and 150-plus playgrounds. Many high-profile installations include the Rockaway Beach, Central Park and the Hudson River Park. NYSDOT employs the use of parking barriers and fence posts on the I-87 and I-95 corridors.

Table 1: Summary of Beneficial Use Options – Part 360/BUD Status and Requirements

Option	**PVC/HDPE Applicability**	**Required Preprocessing & Testing**	**Part 360/BUD Status**	**Citation/Source**
4.1 Structural Lumber	Both are suitable; HDPE is preferred for structural use	Sorting, cleaning, shredding, pelletizing; ASTM D638, D790, D570, D695	**Predetermined BUD** (§ 360-1.15(b)(8))	Tangent Materials; Minde et al.
4.2 Plastic Aggregate	Limited to 2.5-5%; HDPE is more compatible	Cleaning, drying, shredding; ASTM C39, C138, C642, C143	**Case-Specific BUD Required**	Mohamedsalih et al.; Minde et al.
4.3 Plastic Bricks	Both are suitable; different processing temps	Sorting, cleaning, shredding, melting; ASTM C67, E119	**Case-Specific BUD Required**	Yadav et al.

4.4 Energy Recovery	Both suitable; PVC produces more HCl	Metal removal, waste blending; continuous emissions monitoring	**NOT a BUD pathway**	Themelis; NYSDEC Part 360
4.5 Landscape Products	Both suitable; often co-extruded with UV stabilizers	Cleaning, shredding, compounding; ASTM G154, C1028, G160, D256	**Predetermined BUD** (§ 360-1.15(b)(8))	Tangent Materials

NYC-Specific Context

In particular, New York City's construction and demolition environment presents a challenging place for the recovery and beneficial reuse of both PVC and HDPE. These plastics appear throughout NYC's vertical building systems, like plumbing and insulation, as well as in horizontal infrastructure, including drainage systems and gas distribution lines. As a result, projects by the Department of Design and Construction (DDC), Department of Transportation (DOT), and Department of Environmental Protection (DEP) account for most of the construction plastics that eventually enter the C&D waste stream. New York State's solid waste regulations provide pathways for reuse. Still, the city's dense demolition practices, limited sorting capacity, and need for rapid renovations create obstacles that complicate the recovery of uncontaminated plastic material.

What mainly controls the reuse potential is the New York State Department of Environmental Conservation's Solid Waste Management regulations, which determine when a material cannot be legally classified as waste. PVC or HDPE that comes from demolition can only be reused without a solid waste permit that shows that it is safe and appropriate for a different usage. New materials produced by modern agencies are easier to get certified, while plastics removed from older buildings get tested very harshly due to potential contamination from nearby hazardous materials. Only the uncontaminated plastic is allowed at Construction & Demolition Debris Handling/Recovery Facilities, which limits the recovery of PVC components that are in buildings, mechanical systems, or materials that are exposed.

NYC's allowing more policies offers a better environment to promote beneficial reuse. Circular economy efforts that are led by initiatives such as the NYCEDC Circular Construction Guidelines often encourage many designers and contractors to try to specify recycled content materials and to acknowledge deconstruction practices that maintain the quality of reusable components. While Local Law 97 does not regulate materials directly, its carbon reduction makes sure that it can create indirect pressure for the construction sector to adopt low embodied carbon alternatives, even using those made from recycled plastics. Senate Bill A1802A requires municipalities of over one million residents to go and recycle or reuse at least 50% of recoverable materials by weight, but it deprioritizes plastics because of their low density compared to concrete and metals. This method of using weights leads to weak economic connections for people to invest in plastic recovery technologies.

The limitations in NYC worsen the city's ability to actually use plastic recycling systems. Most C&D recovery facilities try to use heavy aggregates because their economic value and landfill diversion qualities are more drastic. However, plastics require polymer categorized sorting processes. This includes optical sorting and density separation, which are not popular within the city. Therefore, even the high-quality HDPE removed during demolition may not be processed locally and must be shipped out of state. This ends up increasing both the cost and carbon footprint, which is troubling to the city's economy and environment. The city's lack of new industrial space and harsh zoning laws for waste handling facilities make this issue even worse. This is because doing so decreases the probability that the new plastic processing capacity will be built without incentives or large commitments.

Nevertheless, NYC has seen early efforts that are more optimistic towards the viability of plastic reuse. Parks and other projects have tried using recycled plastic for boardwalk repairs near beaches, using HDPE for its durability and moisture resistance. Many stormwater management installations have used HDPE-based recycled components, showing how it agrees with NYC environmental standards. Communities have started production of compressed plastic bricks and blocks recovered from waste streams, showing the opportunities for neighborhoods to start reusing and making an impact. Even if large-scale industrial processing is restricted, smaller-scale ones, like communities, can have applications that remain possible.

New York City's ability to scale reuse of PVC and HDPE will depend on improving the regulations and on how well the material's ability to recover is. Pre-demolition material audits could increase the supply of uncontaminated plastics by making sure they are targeted for removal before any mixing and contamination can occur. Public standards need a minimum recycled plastic content in specific building components, which could stimulate demand and help stabilize markets. A strategic investment in polymer-specific processing lines at select C&D recovery facilities would address the city's lack of sorting capacity. Although PVC has its challenges due to its chlorine content and unique chemistry, HDPE is more than capable of supporting NYC's construction goals under the correct measures.

Conclusion

PVC and HDPE are construction plastics that make up a large resource stream within NYC's construction transition. Their physical and chemical properties determine their reuse methods. HDPE's recyclability, ductility, and chemical stability make it great for use in new construction. However, PVC's durability and chlorine composition make it more appropriate for longer applications rather than recycling.

Reuse strategies range from polymer concrete and lightweight plastics bricks to even recycled plastic and energy recovery. These methods show clear environmental success, especially in carbon reduction, landfill diversion, and recycling efficiency. However, each method carries restrictions that are connected to the risk of contamination.

Within NYC's policies, the possibility of each reuse strategy depends on material science and Part 360 BUD approvals, C&D handling regulations, local market infrastructure, and city sustainability mandates. HDPE-based pathways are the most viable now, especially in drainage systems and landscaping. PVC is looking more optimistic, but reuse is limited because of its chemical makeup, as it lacks processing capacity and stricter regulations.

The overarching challenge is simple, yet systemic, and it is that NYC lacks consistent polymer sorting, stable end markets, and a facility capacity dedicated to plastics. Addressing these gaps will be a struggle, but it is possible with technological and economic interventions.

Ultimately, the beneficial use potential of PVC and HDPE in NYC lies at the intersection of materials engineering, environmental policy, and urban market dynamics. NYC can meaningfully expand on how it effectively uses materials for construction plastics by reducing waste, supporting climate goals, and advancing a stronger, more structured environment, if the city can get started today.

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