CLEAN AND CIRCULAR:

Design & Construction Guidelines

NYC EDC

Version 1.0

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LETTER FROM NYCEDC PRESIDENT

New York City's more than one million buildings are responsible for nearly 70 percent of the city's greenhouse gas (GHG) emissions. In a world grappling with escalating urgency to respond to the climate crisis, we stand at a critical juncture to decarbonize buildings and construction. At New York City Economic Development Corporation (NYCEDC), we are committed to delivering sustainable infrastructure for communities while also investing in jobs and sectors that will help NYC combat climate change. Decarbonizing our built environment requires us to reimagine our approach to design and construction, embracing circular principles that maximize resource efficiency and reduce construction and demolition (C&D) waste.

As part of the City's decarbonization efforts, NYCEDC is launching the ***Clean and Circular: Design & Construction Guidelines***, an operational toolkit to reduce embodied carbon and waste in NYC's built environment.

Implementing the Circular Design & Construction Guidelines advances a key objective within NYC's *Green Economy Action Plan*, released by NYCEDC and the Mayor's Office of Talent & Workforce Development in February 2024, to decarbonize buildings and construction. Currently the buildings sector makes up the largest share of NYC's green economy, representing nearly 50 percent of green economy jobs. Green jobs in the buildings sector are expected to more than double by 2040 and be the most significant driver of future green economy growth in NYC, positioning us to drive significant impact in our efforts to build more sustainably.

The Circular Design & Construction Guidelines will be implemented across all NYCEDC capital projects beginning in 2024, driving demand for lower carbon construction across NYCEDC's $9 billion capital portfolio and serving as a tool for industry to chart a path forward to minimize embodied carbon, reuse and recycle materials, and divert waste from landfills. The Guidelines will support upskilling across design and construction companies and outline a new set of standards NYCEDC will expect from partners to drive cleaner and more circular projects to completion.

The next decade will be critical to chart a collective path towards a climate positive future. Whether you're an architect, engineer, construction manager, public servant, policymaker, construction worker, or manufacturer in NYC, we invite you to explore how these Guidelines may fit within your own core competencies and join forces in building a more sustainable future. Together, we can embark on a transformative journey, shaping a city that serves today's needs while safeguarding resources for generations to come.

Andrew Kimball
President & CEO
NYCEDC

EXECUTIVE SUMMARY

The City of New York (the "City") is set to play a powerful role in decarbonizing the built environment and scaling the clean and circular construction industry by enabling innovative solutions, facilitating bold policies, and operating programs to overcome implementation challenges in tangible ways.

As part of the City's decarbonization efforts, New York City Economic Development Corporation ("NYCEDC") is implementing *Clean and Circular: Design and Construction Guidelines for the Built Environment* (the "Circular Design and Construction Guidelines"), a guide to reduce embodied carbon in NYC's built environment.

NYC aims to reduce embodied carbon emissions for new buildings, infrastructure, and major retrofits by 50 percent (*PlaNYC* 2023)[1]. Currently, materials, including their extraction, transport, and manufacturing, represent approximately 70 percent of all embodied carbon emissions in the built environment.[2] This will allow the City to move from a linear to a circular system, in which materials are not wasted and maximize the economic value of decisions made in both design and construction.

Positioned between public and private industry, NYCEDC will facilitate demand and build capacity for circularity and embodied carbon reductions through procurement of contractors on capital projects. This supports NYC's green economy vision to decarbonize buildings and construction by creating an embodied carbon strategy across the $9 billion portfolio, which will:

1. **Target outcomes within NYCEDC capital projects**
2. **Drive demand for low-carbon design & construction**
3. **Develop knowledge and capacity across industry stakeholders, including design teams & construction managers**

To achieve these goals, the Guidelines contain a series of best practices and phases across a project's life cycle (preconstruction through deconstruction) to guide project teams towards compliance.

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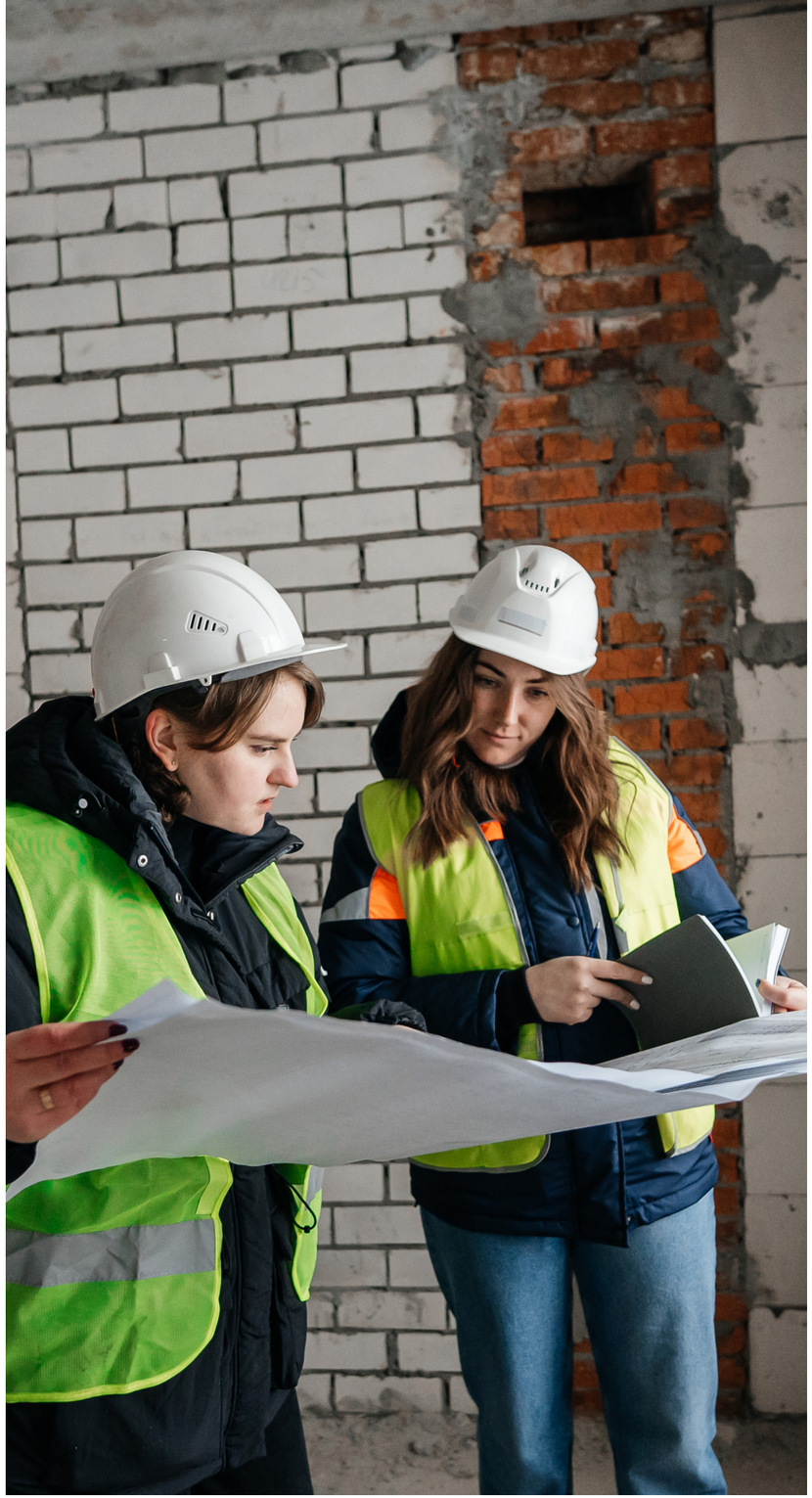
CIRCULAR ECONOMY IN THE BUILT ENVIRONMENT



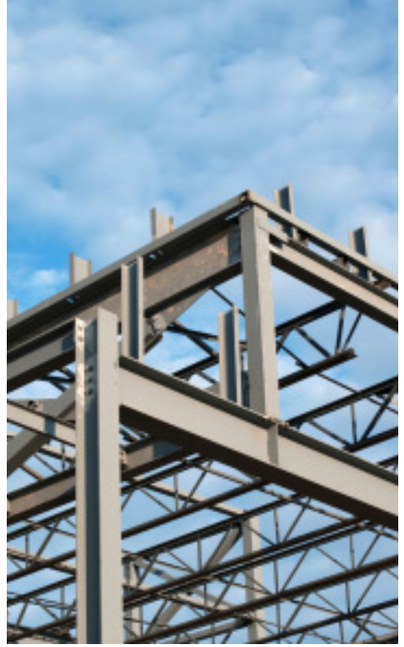
NEW YORK CITY CONTEXT

As a leader in climate action, New York City has set ambitious goals to create a more equitable, healthy, and resilient future. The City has committed to achieving carbon neutrality by 2050 within its strategic climate plan; *PlaNYC*: *Getting Sustainability Done*.[3] Through the Climate Mobilization Act in 2019 and Local Law 97, much attention has been given to reducing operational carbon in the built environment, referring to the carbon emissions associated with the energy used to operate buildings and infrastructure. New York City is now well positioned and aiming to reduce embodied carbon; the emissions associated with the extraction, production, transport, and manufacturing stages of building materials and construction. Embodied carbon is the next frontier of New York City's decarbonization efforts and the focus of the *Clean and Circular Design & Construction Guidelines* ("Guidelines").

Buildings are responsible for almost 70 percent of New York City's total greenhouse gas emissions, and construction and demolition (C&D) waste represents up to roughly 60 percent of the local solid waste stream.[3] Globally, 40 percent of annual CO2 emissions come from the built environment, including 13 percent from materials and construction4.[4] Unlike a linear economy in which resources are disposed of at the end of their use, a circular economy optimizes resource design and enables their continued use. The urgency to mitigate carbon emissions from the built environment calls to maximize the potential of the City's existing building stock while driving towards new low-carbon construction. This requires shifting to a circular building culture that eliminates the concept of waste and challenges the way materials, buildings, and urban systems are designed in relation to their lifetime.

A key first step, New York City committed to reduce embodied carbon in the construction industry 50 percent by 2033 in *PlaNYC: Getting Sustainability Done*. Mayor Eric Adams signed the Clean Construction Executive Order 23 of 2022[5]5 committing all City capital project agencies to develop action plans to incorporate low-carbon concrete specifications, environmental product declarations (EPDs), low-emission vehicles and equipment, and life cycle assessments (LCAs). The City has doubled down on its *PlaNYC* commitment by signing onto the C40 Clean Construction Accelerator in April 2023, committing all new building construction and major retrofits by the City's Capital agencies to reduce embodied carbon 50 percent by 2030. With bold and ambitious commitments in place, it's time to take action to ensure we can deliver.

In NYC's *Green Economy Action Plan*, New York City Economic Development Corporation (NYCEDC) puts policy into practice by identifying a path forward to tackle embodied carbon within its own capital portfolio and set a precedent for City agencies and industry to follow. As a mission-driven organization delivering future-forward infrastructure and capital projects on behalf of the City, NYCEDC will leverage its procurement power across the Capital Portfolio to encourage circular innovations and catalyze action to facilitate both supply and demand of circular project delivery.



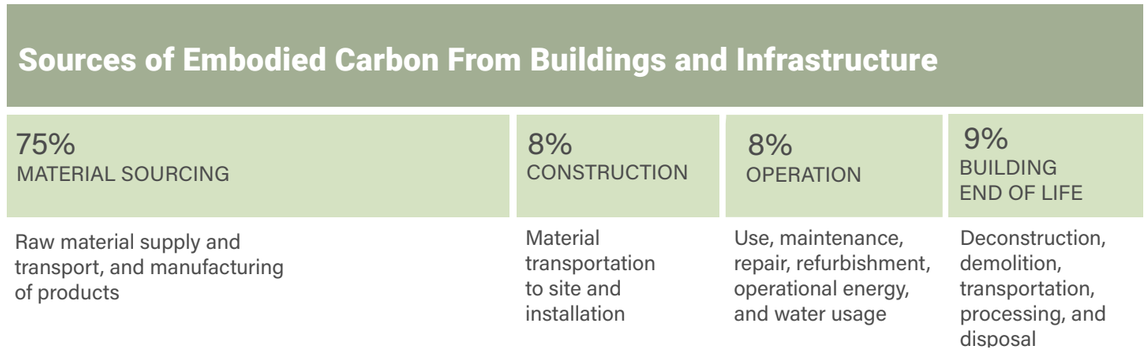
Clean Construction Executive Order 23

Executive Order 23 directs capital project agencies to reduce greenhouse gas emissions through the following actions:

- Set specifications for low embodied carbon concrete for use in capital projects
- Submit environmental product declarations (EPDs) for structural steel and concrete
- Include specifications in capital project construction contracts for low-emission vehicles and equipment
- Complete a Life Cycle Assessment (LCA) for applicable projects to quantify the environmental impact of the whole project

The City plans to build on these specifications in the future. For full details on Executive Order 23, refer to Executive Order 23 | City of New York (nyc.gov).

Figure 1. Sources of Embodied Carbon from Buildings and Infrastructure



Opportunity for Impact

New York City's large volume of new buildings and infrastructure results in high embodied carbon emissions and C&D waste.

- In NYC, construction and demolition (C&D) waste represents up to 60 percent of solid waste
- In 2019, approximately 8,000 new building permits were issued and roughly six million tons of C&D debris were generated in NYC
- Approximately 10 percent to 15 percent of construction materials brought onto a job site are not utilized and discarded
- Construction is responsible for 50 percent of natural resource extraction globally
- Cement manufacturing alone accounts for eight percent of global GHG emissions, and iron and steel production accounts for 7 percent of global GHG emissions

Rather than using strategies to maximize material use/reuse or minimize waste, these wasted materials are sent for processing or disposal. This amounts to lost nonrenewable resources, unnecessary emissions, and an inefficient use of money and capital.[7]

This document, the *Clean and Circular Design & Construction Guidelines* ("the Guidelines"), is NYCEDC's invitation to the design and construction industry to join the City on the path forward to achieve clean and circular construction.

The Guidelines are an operational toolkit created to support design and construct teams' efforts to deploy circular strategies within NYCEDC Capital Projects. They outline new deliverables to track data and materials, establish circular decision points along a project's workflow, and outline a compendium of circular design strategies which will be evaluated for feasibility and impact within each project's scope and site.

Figure 1 illustrates the average portions of embodied carbon that are associated with each phase of a business-as-usual building within a linear economy: Preconstruction (material sourcing during planning and design), Construction, Operations, and Building End of Life (decommissioning and deconstruction).

Unlike operational carbon, embodied carbon is locked in place at the start of a building's life cycle through the materials extraction, procurement, and construction processes.[8] When buildings are demolished and C&D waste is discarded, the carbon, energy, and labor value embedded within materials are lost, simultaneously increasing demand for new resource extraction. The embodied carbon emissions from the built environment can be reduced by following the hierarchy of circular design principles outlined in Figure 2, beginning with an assessment of materials reused directly on site through structural components and materials. The four circularity principles in order of impact potential are 1) Build Only What Is Needed, 2) Build With the Right Materials, 3) Build Efficiently, and 4) Build for Long Term Value.

VISION AND OBJECTIVES: BUILDINGS AS MATERIAL BANKS

The most sustainable building is one which already exists. Circular design and construction practices aim to eliminate waste from a project wherever possible and preserve the remaining materials to be reused, recycled, or remanufactured at their highest-use value. NYCEDC imagines a future built environment where buildings are material banks, resources held in place to be salvaged and used in future construction at the end of their initial life. Every building system and component, from structural steel to a door, has potential to be reused or refurbished. This transition to a circular construction industry requires new skills, methods, and processes to quantify and design material flows between the existing building stock and new construction. Currently, New York City produces on average 7,500 tons of construction and demolition waste per day.[3] For the percentage of C&D waste that is recycled, most of it is downcycled and loses value through diversion outside of the building sector. This volume of a consistent local C&D waste stream presents a tremendous opportunity of scale to recover and reuse materials at the end of their function life, a process known as urban mining. The first step in any mining process is to evaluate and identify the quality and quantity of materials available. For new buildings and infrastructure undergoing construction, it is important to design for their potential to be disassembled and reused, taking into consideration standardization of assembly points and components.

Clean Construction Executive Order 23

The recent Clean Construction Executive Order 23 highlights the connection between high-embodied carbon manufacturing and production processes for key construction materials and global greenhouse emissions:

- Eight percent of global greenhouse gas emissions are from the embodied carbon from cement manufacturing.
- Seven percent of global greenhouse gas emissions are from the embodied carbon from iron and steel production[8].

Figure 2. Circular Design and Construction Principles to Achieve Embodied Carbon Reduction

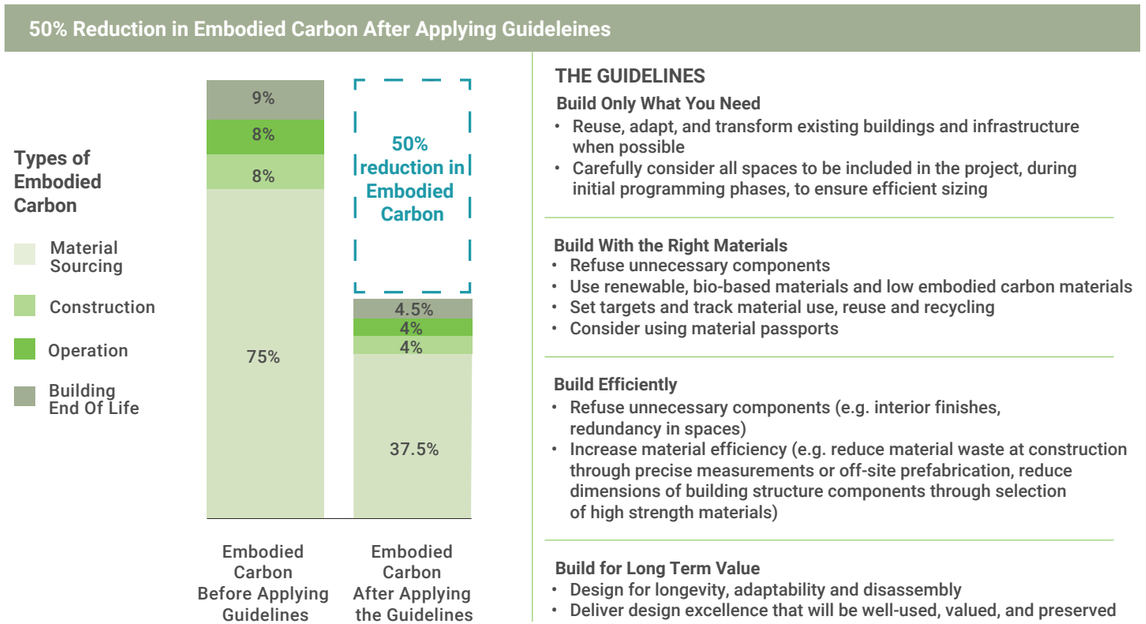
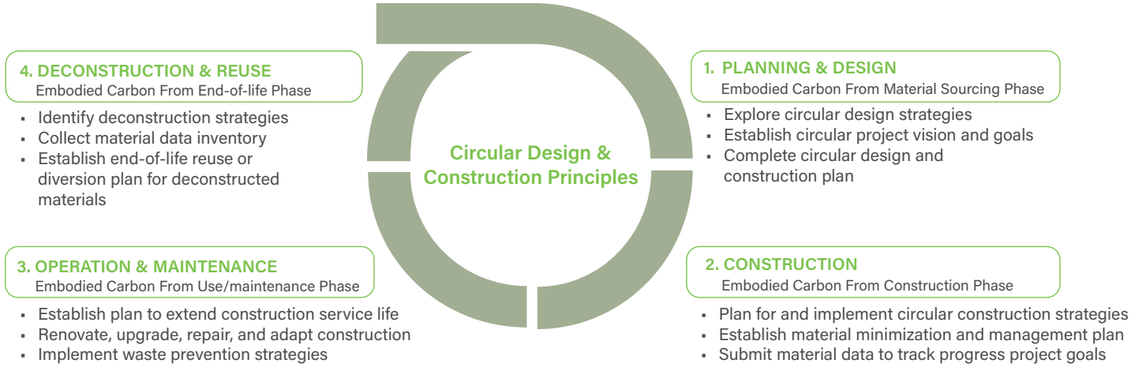


Figure 3. Applying Circular Design and Construction Practices During the Life Cycle of Buildings/Infrastructure[6]



Deconstruction Jobs Support Sustainable Equitable Growth

Deconstruction aims to divert materials away from landfills into local supply chains and materials markets. Deconstruction is more labor intensive than demolition and has the potential to create well-paid entry-level jobs in the construction trades.[1] In addition to jobs created in structure removal, deconstruction also creates additional jobs for transportation, warehousing, and reuse of salvaged materials.[9] A report prepared for the City of San Antonio Office of Historic Preservation estimated two to three times more workers are needed for deconstruction compared to mechanical demolition and 300 jobs per 10,000 tons of materials are available through reuse/refurbishment compared to one to six jobs in the traditional landfilling/ incineration process.[10]

While tremendous opportunities to reduce embodied carbon exist, knowledge, infrastructure, and data to support circular design and construction are currently underdeveloped in the United States. To aid in the transition to a circular design and construction paradigm, these Guidelines establish interventions across the life cycle phases of a building or infrastructure. These phases include the Material Sourcing Phase, Construction Phase, and End-of-Life Phase. **Figure 3** highlights how circular practices can be applied over the lifecycle of NYCEDC Capital Projects.

The Guidelines prompt design and construction teams to set project goals for material reduction and reuse, low-carbon materials sourcing, and require data collection to track performance over time. As the process is implemented and data is collected, the learnings will be evaluated and adopted into future revisions of the Guidelines.

To achieve these goals, the Guidelines outline best practices and strategies that can be applied to various phases of a project life cycle with a specific focus on those that directly contribute to the embodied emissions of building materials and construction.

The Clean and Circular Design & Construction Guidelines utilize a project-lifecycle approach with a focus on the following project phases:

Phase 1: Preconstruction includes planning and design work prior to procurement of contractors, materials, and equipment

Phase 2: Procurement, Construction, and Renovation includes procurement of contractors, materials, and equipment and activities relating to construction for both new projects and renovations

Phase 3: Operations includes activities required to operate and maintain the building or infrastructure once construction is complete

Phase 4: Decommissioning and Deconstruction includes activities to manage buildings or infrastructure at the end of their useful life

Phases 1, 2, and 4 each present a range of opportunities to implement strategies to minimize construction and demolition waste (C&D waste), increase use of alternative low-carbon construction materials, and operationalize circular construction and deconstruction practices. The following section provides a toolkit of strategies that will be implemented in collaboration with key project stakeholders. Design and construction teams will need to deploy different strategies to achieve embodied carbon reduction goals depending on the specific needs of the project and should identify strategies that enable them to keep materials at their highest and best use.

These Guidelines are organized as follows:

Chapter 1. Defining Circular Economy in the Built Environment establishes the vision and objective of the Guidelines in context of New York City's emerging embodied carbon policies.

Chapter 2: Operationalizing Circular Design and Construction outlines circular goals and metrics, roles and responsibilities, and overall project workflow and deliverables.

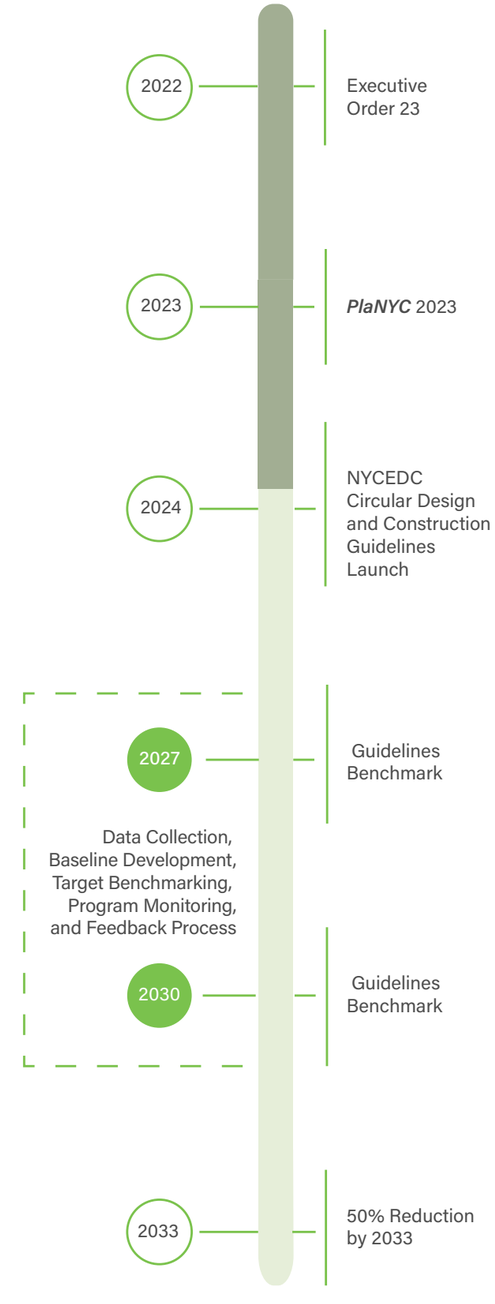
Chapter 3: Implementation Strategies provides a toolkit of circular design and construction strategies to be evaluated in each project's development phase.

Appendices

- **Appendix A.** Existing State and Local Policies, Laws, and Regulations outlines local policies, laws, and regulations driving the need for reductions in embodied carbon and setting the phase for the goals for these Guidelines.
- **Appendix B.** State of the Industry provides an overview of peer jurisdictions and agencies, which was used to inform goals, metrics, tracking requirements, and strategies in these Guidelines.
- **Appendix C.** Circular Design and Construction Plan provides a template of the Circular Design and Construction Plan (CDCP), a required deliverable to be submitted to NYCEDC per project.

As shown in **Figure 3**, these Guidelines have established goals, standards for data collection, and strategies to reduce waste and embodied carbon. The Circular Design and Construction Guidelines outline a procedural framework and visionary launchpad to design and build in accordance with circular principles within NYCEDC's Capital Program and Asset Management Division (CAP). NYCEDC aims to promote the development of circular buildings at scale and encourage circular innovations by facilitating both demand through procurement practices and the required collaboration of all project stakeholders. **The Guidelines will be integrated into all applicable Requests for Proposals (RFPs) beginning in 2024**. The goal is to familiarize architects, engineers, construction managers, contractors, and other project partners with circular design and construction to deploy tangible strategies to reduce C&D waste and embodied carbon across all projects.

Figure 4. Applying Circular Design and Construction Practices During the Life Cycle of Buildings/Infrastructure



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CIRCULAR DESIGN AND CONSTRUCTION

GOALS & METRICS

The Guidelines will support the City's decarbonization goals while enabling the construction industry to transition towards low-carbon and circular practices.

NYCEDC has identified three primary circular goals that will apply to all NYCEDC Capital projects. The first two goals target material diversion, reuse, and recycling. The third goal focuses on increasing use of low-carbon alternative building materials.

Goal 1: Divert Construction and Deconstruction Material from Disposal

Reduce C&D waste by 75 percent for all projects. For new construction projects, 75 percent of the C&D materials (by weight or volume), must be either reused or recycled. This includes form and falsework, framing, excess materials, and damaged materials. For deconstruction projects, 75 percent of the C&D materials identified and salvaged during deconstruction, renovation, and rehabilitation must be diverted from landfill for other uses, either via reuse or recycling.

Goal 2: Reuse and Recycle Concrete and Soil

Reuse and/or recycle a minimum of 95 percent of the discarded concrete and soil generated by a construction or deconstruction project.

Goal 3: Use Low-Carbon Building Materials

Ensure at least 25 percent of all materials used on a project are low-carbon. Figure 6 outlines common construction materials and associated amounts of embodied carbon reduction required to be considered sustainable.

A variety of alternative construction materials have low embodied carbon with high recycled content, optimized mixes, and other options, as shown on **Figure 6**. This includes concrete, rebar, insulation, glazing, and finish materials such as paint.[6] This may also include renewable natural materials such as mass timber, hempcrete, and bioplastics.

FOCUS MATERIALS

To meet the Guidelines goals, project teams will develop Circular Design and Construction Plans (CDCP) that identify focus materials and strategies for material diversion and reuse. **Table 1** includes the materials that make up 90 percent of the New York State C&D waste stream and have the most potential to reduce GHG emissions from construction. Project Teams should carefully consider all material inputs, but should pay most attention to the materials outlined in the table below given their significance in reducing both waste and embodied carbon. While the table outlines materials' circularity potential and pathways for reuse and remanufacturing, Project Teams will need to work creatively and collaboratively with NYCEDC to develop a materials sourcing and management approach that priorities reuse and use of low-carbon alternatives to carbon-intensive materials like concrete and steel.[11]

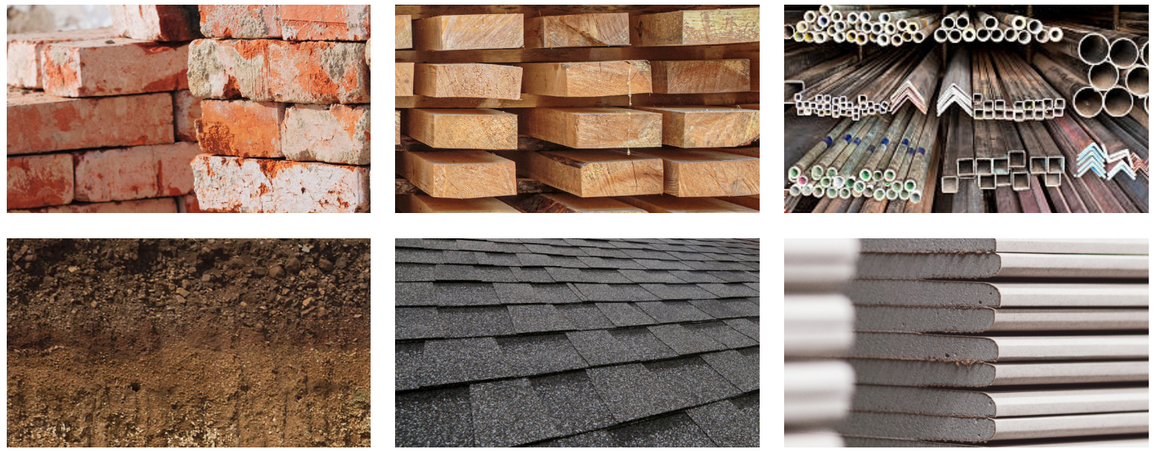

Table 1: Material Composition of New York State Construction & Demolition Waste Stream[12]

	Masonry	Wood	Metals	Soils	Roofing	Drywall
Composition of C&D Debris by Weight	35%[13]	15%	6%	27%	5%	2%
Source / High Generator	Infrastructure	Residential/nonresidential buildings	Nonresidential buildings	Infrastructure and new building construction	Residential/ nonresidential buildings	Residential/ nonresidential buildings
Applicability to NYCEDC Project Type	Construction and deconstruction of existing infrastructure, including roadways, sidewalks, buildings, parks, open space, waterfronts, parking lots	Construction, deconstruction, and renovation of building and interiors	Construction and deconstruction/ renovation of building and interiors including copper piping, aluminum duct work, steel beams, and rebar	Construction and deconstruction of existing infrastructure, including roadways, sidewalks, buildings, parks, public areas, boardwalks, parking lots	Construction and deconstruction/ renovation of building and interiors	Construction and deconstruction/ renovation of building and interiors
Existing Markets and Circularity Potential	Emerging solutions to reducing emissions in cement production through use of supplementary cementing materials such as ground glass pozzolan	Clean yard debris for landscape mulch/some nontreated wood used as wood chip fuel	Reused as ferorous and non-ferrous scrap metal	Reuse onsite for topsoil and plants as well as onsite fill or use in New York City's Clean Soil Bank	Asphalt shingle scrap can be used in pavement, sidewalks, driveways, road and ground cover, and many other products[18]	Gypsum can be recycled into new drywall if most of the paper is removed
Reuse & Remanufacturing Opportunities	Ubanite for patios[15]/ walkways[14] Masonry can be cleaned and reused as concrete in structural components	Reclaimed wood for flooring, walls, and furniture or regraded for load-bearing applications[16]	Steel construction components are highly reusable and can be inspected, refabricated, and primed to the requirements of the new project[17]	Geotechnically and environmentally impacted soils can reused in many onsite applications	High potential for reuse in roadway projects[19]	Certain drywall manufacturers can accomplish close loop recycle drywall

PROJECT WORKFLOW

Figure 9 shows example outlines of a typical project workflow incorporating the circular design, construction, and de-construction tasks into the NYCEDC project delivery framework for new construction. NYCEDC will lead and complete the following tasks:

- NYCEDC will coordinate with the Asset Owner to determine the intended purpose and need of the project.
- NYCEDC will release an RFP to procure the Design Team to develop building or infrastructure design referencing the Guidelines document. Design, construction, and/or deconstruction teams will submit proposals to NYCEDC for evaluation; each proposal will include an approach to conducting the Circularity Audit, the Circularity Workshops, the CDCP (including LCA and Materials Management and Waste Management Plan) and identifying associated costs. NYCEDC will then select the awarded team.
- During or after completion of the design phase, the CM will procure one or more Contractors to execute construction of the project. The procurement packages will include the Circularity Audit Report and CDCP. Contractors may be solicited for input on improvements and implementation of the CDCP. Awarded Contractors will carry out the construction or deconstruction using strategies identified in the CDCP and begin reporting on required metrics.

Circularity Audit

A review of existing assets and site conditions to conduct a materials inventory and determine reuse potential. This project task will provide project stakeholders with the necessary information and data required to make decisions to deploy circularity principles within the project scope and determine the second life of existing building materials and components on the project site. Emerging construction technologies, innovations, and research are welcome to assist in the delivery of a successful circularity audit.

Circular Design and Construction Plan (CDCP)

The primary deliverable to track circularity progress and collect data through project workshop. The CDCP must be submitted for every NYCEDC Capital project informed by the Sustainable Design Workshops and Circular Audit, proposing project specific material goals and strategies. The CDCP will be incorporated into procurement documents and used to specific material.

Materials Management & Waste Minimization Tracker (Materials Management Tracker)

Materials Management and Minimization Tracker: A living data collection document informed by the findings of the Circularity Audit and Life Cycle Assessments (LCAs) to track and manage material flow through a project's lifecycle. The Materials Management Tracker should propose a data-collection methodology and logistics specific to each project scope.

Figure 5: Circular Tasks and Decision Points Embedded into Project Workflow

Circular Tasks Embedded into Project Workflow

Conceptual Design

- Assess reusing existing asset components
- Evaluate opportunity for deconstruction or renovation over demolition
- Conduct a **Sustainability Workshop** to make early decisions on materials reuse and re-purposing

Schematic Design

- Set an **Embodied Carbon Target** for the project
- Conduct a **Circularity Audit**
- Conduct a **Circular Design and Construction Workshop** to finalize strategies and establish a **Circular Design and Construction Plan**
- Evaluate opportunity for deconstruction or renovation over demolition

Preliminary Design

- Assess Circularity Audit; determine which materials can be re-purposed and reused on the project
- Identify low-carbon material alternatives that will help meet project emissions targets
- Evaluate availability of identified material palette
- Conduct Life Cycle Analysis (LCA)
- Develop data collection methodology via Material Management & Waste Minimization Tracker

Final Design

- Specify material that will be salvaged; coordinate logistics and storage
- Incorporate Circular Design and Construction Plan into procurement documents

Construction Procurement

- Confirm alignment on goals, objectives, and design strategies across project stakeholders
- Evaluate and update data collection methodology via **Material Management & Waste Minimization Tracker**
- Contractors demonstrate goal and plan achievement in proposal and bid documents

Construction Administration

- Obtain all Environmental Product Declarations (EPDs) from material manufacturers
- If needed, revise the CDCP for the construction phase, including the Materials Management Plan
- Consider as-built LCA, or update from design LCA
- Submit final CDCP and Materials Management Plan with documented efforts, benchmarked targets, and data inventory

Circular Decision Points with NYCEDC

PROJECT TEAM ROLES AND RESPONSIBILITIES

NYCEDC Roles & Responsibilities

NYCEDC Project Manager and/or Supervisor

The Project Manager (PM) oversees delivery capital design and construction projects at NYCEDC on behalf of the Asset Owner/ Manager.

The PM will:

- Lead day-to-day management, including the project schedule, budget, and coordination between internal and external project teams.
- Identify other necessary staff to refine Circular Design and Construction project goals
- Work with the Design Team to facilitate Circularity Workshops.
- Oversee the Circularity Audit.
- Review the draft Circular Design and Construction Plan .
- Coordinate with construction teams to track data progress and final towards goals identified in the CDCP.

Asset Owner and/or Manager

The Asset Owner and/or Manager can be within NYCEDC or a representative of an outside entity (e.g., a City agency) that owns or manages the facility/asset that has been put before NYCEDC for renovation, reconstruction, new construction, or deconstruction.

External Project Stakeholder Roles and Responsibilities

Design Team

The Design Team is responsible for managing the overall circular design implementation, including:

- Complete the Circularity Audit.
- Develop a Circular Design and Construction Plan to track materials for reuse, diversion, recycling, or disposal.
- Complete a Material Management and Waste Minimization Plan, a requirement within the CDCP.
- Document the type and quantity of materials that exist onsite and are planned for reuse, as well as identifying potential sources for reused materials that originate offsite.
- Work alongside NYCEDC to identify the most appropriate and effective goals to reduce the project's embodied carbon emissions and waste.

Adjustments to the initial project goals may be necessary and must be coordinated with and accepted by NYCEDC.

Managers - Design SMM and Construction SMM

Sustainable Materials Managers (SMM) will be necessary during both the Design and Construction Phases of a project.

During design, the Design SMM will be part of the Design Team team and responsible for overseeing the implementation of the Material Management and Waste Minimization Plan with the Contractor.

The Design Phase SMM will:

- Track compliance with project goals at milestone review submissions and provide guidance to the project team.
- Work with the Lead Architect and Engineer to develop the LCA.

During construction, the Construction SMM will:

- Implement the CDCP, in partnership with the Construction Manager and Contractor.
- Propose any necessary revisions to the CDCP and the Material Management and Waste Minimization Plan.
- Report to NYCEDC on the disposition of materials that are identified for reuse, diversion, recycle, or disposal during construction. For example, the Construction SMM will oversee the procurement of the low-carbon materials and coordinate site logistics for the storage of reusable materials.
- Ensure that the project conforms to and fully documents all circular design and construction requirements. It is encouraged, although not required, that the Construction SMM be either LEED or Envision certified, depending on the type of project.

Construction Manager (CM)

The CM will procure and manage work performed by the Contractor(s).

The CM will be responsible for:

- Ensuring that the Contractor implements the plans, goals, and strategies outlined in the CDCP, including the Material Management and Waste Minimization Plan
- Receive weekly and/or monthly reports from the Contractor to track and report on facilitating material flows on and offsite, including material reuse and sustainable material alternatives that will be incorporated into the project by weight or volume or number, and verifying information in the reports jointly with the Construction SMM.
- Tracking the Contractor's progress and coordinating with the Design Team on the LCA for the project at completion.

Contractor

The Contractor will be procured and managed directly by the CM to perform the trade work in the renovation, construction, or deconstruction of the building or infrastructure. In doing so, the Contractor will coordinate the use of materials, labor, and equipment.

The Contractor will be responsible for:

- Reporting to the CM the materials used on the project by providing progress updates on the CDCP and data inputs to the Material Management and Waste Minimization Plan by volume, weight, or quantity, as well as any other metrics determined necessary from EPDs, material passports, and material specifications

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IMPLEMENTING CIRCULAR STRATEGIES

CIRCULAR DESIGN AND CONSTRUCTION STRATEGIES

To put circular design and construction into practice and meet the outlined goals, the Guidelines contain a series of strategies for design and construction teams to consider and deploy. The Guidelines prioritize Phases 1, 2, and 4 of a project's life cycle, which constitute the majority of NYCEDC-led capital projects. Further details and case studies are presented for each strategy in Part 3 of the Guidelines.

In addition to drawing from the menu of strategies in **Table 5**, each design and construction team is expected to create a tailored plan to divert waste and use low-carbon materials that meet the needs and conditions of that unique project.

Table 7. Summary of Circular Design and Construction Strategies

	Phase 1: Preconstruction (Planning and Design)	Phase 2: Procurement, Construction & Renovation	Phase 4: Decommissioning/ Deconstruction
Circular Strategies	Complete a Circularity Audit Conduct a Sustainability Workshop (**Appendix C**) Conduct a Circular Design & Construction Workshop (**Appendix C**) Use Building Information Modeling (BIM) to optimize material use/reuse Plan for materials reprocessing/reuse on site Plan for material recycling Specify the use of reclaimed/recycled materials Identify applicable circular design strategies Design to eliminate new buildings or infrastructure Design for modularity/offsite construction of building components Design for longer building and infrastructure life span Design for disassembly and deconstruction Design for materials optimization Design for adaptability and adaptive reuse of space	Track strategies and targets identified in the CDCP Develop a logistics plan to store reuse material on site or identify alternative end uses to divert materials Enable contractors to source alternative low-carbon, reclaimed, and/or recycled materials Submit EPDs and material passports for material procurement	Conduct Circularity Audit at decommissioning Analyze potential for structural reuse Develop a logistics plan to store reuse material on site or identify alternative end uses to divert materials Determine scope for deconstruction in lieu of demolition
Required Actions for NYCEDC Consultants and Contractors	Complete a Circularity Audit—determine if new construction is needed or if existing buildings and infrastructure can be renovated or reused Conduct a Sustainability Workshop Conduct a Circular Design & Construction Workshop Prepare a Circular Design and Construction Plan—Design Team will be required to develop a CDCP (identifying strategies, roles, tracking plans)	Track progress on the strategies and targets identified in the CDCP — Contractor to review the CDCP and make any necessary adjustments Identify innovative procurement strategies—ideas for incentives, penalties, discounts on bid pricing for low-carbon emissions or increased materials reuse, penalties for rework that results in a higher carbon footprint Follow CDCP and submit required tracking information	Complete a Circularity Audit—determine if existing buildings or infrastructure can be renovated or structurally reused, or if building components can be deconstructed for reuse or remanufacturing/provide materials inventory and recommendation If new construction is needed, refer to Phase 1 steps for planning and design

PLANNING AND DESIGN

Phase 1 Requirements

The Preconstruction Phase is the highest-impact opportunity for Design Teams to influence the circularity of a construction or deconstruction project. During Phase 1, the Design Team will be required to complete the following steps and deliverables:

- **Circularity Audit**
- **Sustainability Design Workshop**
- **Circular Design & Construction Workshop**
- **Circular Design and Construction Plan (CDCP) —Planning and Design**

Consultants are required to develop a CDCP that will:

- Identify circular construction strategies used during design, including a Lifecycle Assessment (LCA) to assess the carbon impact of the proposed strategies
- Develop the Materials Management and Waste Minimization Plan to set targets for material reuse and diversion and use low-carbon material alternatives
- Identify reporting milestones and mechanisms to track tasks and progress across both the CDCP and Materials Management Tracker
- Identify barriers to achieving the Guidelines' outlined goals upfront to allow time for collaborative problem-solving (e.g. technical feasibility, cost, lack of resource availability within NYC market)
- Identify Design Team leads responsible for collecting and tracking CDCP elements, including materials, waste diversion, LCA results, and EPDs

Phase 1 Strategies

To meet Phase 1 requirements, Design Teams will identify strategies that are most suitable for the specific project.

Complete a Circularity Audit

The Design Team will perform a Circularity Audit to establish a baseline of material availability within the existing asset and provide an inventory of the quantity and quality of materials that can be retained, reused, recycled, or diverted.

The Design Team will propose the means, methods, and level of detail of the Circularity Audit as appropriate to the individual project.

The Design Team will use the results of the Audit to consider strategies that maximize the use of the existing asset. Circularity Audits will be considered for all projects and required for projects with design costs valued above $500,000.

The Circularity Audit will help define the scope of deconstruction to ensure application of strategies that minimize waste, keep materials in use, and reduce embodied carbon. The inventory will help the Design Team identify and engage with stakeholders and local reuse organizations such as Big Reuse, Brooklyn Reclaimed, and NYCitySlab.

The Circularity Audit will be project specific and will conclude with a deliverable Circularity Audit Report summarizing the findings and include documentation as follows:

- Review of original building documentation and architectural and/or engineering drawings
- A site survey (inspections, measurements, photographs, field tests, sampling, and analysis)
- Assessment of quality and quantity of materials
- A digital twin of the existing asset
- Estimate of the residual values of these materials on the reuse/upcycling/recycling market, based on industry research and local stakeholder engagement
- Recommendations for separation methods and potential reuse and upcycling with priority for onsite and local projects

Conduct Sustainability Workshops

The first Sustainability Workshop will occur during the Conceptual Design phase and include NYCEDC, the Asset Owner, and the Design Team.

The Sustainability Workshops will establish a vision for materials reuse throughout the project's lifecycle. This workshop should, at a minimum, consider the design choices and components that improve environmental performance and reduce net embodied carbon. The workshop will explore circular strategies appropriate for the project scope and site.

A second Sustainability Workshop will occur after the Construction Manager has been on-boarded (approximately Preliminary Design) and will include NYCEDC, the Asset Owner, the Design Team, and the Construction Manager and/or Contractors performing design assistance. The second workshop will consider all phases of the building's life cycle and begin the development of embodied carbon performance objectives. The result of this workshop will be the outline or framework for the CDCP (refer to **Appendix C**).The Sustainability Workshops may include other sustainability topics as applicable to specific projects.

Conduct a Circular Design & Construction Workshop

The Circular Design & Construction Workshop will occur in the Schematic Design phase and include NYCEDC, the Asset Owner, and the Design Team.

Case Study: NYCitySlab, 119 Livingston Street, Brooklyn Heights

NYCitySlab salvages lumber from demolished buildings in NYC for reuse. In Brooklyn Heights, more than 200 beams (pine floor joists) were covered from this existing structure for local resale in 201520, 21. [20 21]

Additional Considerations:

- NYC has a collection of reuse businesses. Additional investments into research and collaboration with local reuse organizations may be required.
- Recertification of recovered materials for reuse may be required, especially for reuse of deconstructed structural components.
- An assessment by a deconstruction expert will aid in determining feasibility for reclaiming deconstructed materials for reuse and upcycling.

The Circular Design and Construction Workshop will finalize the design approach to materials reuse, define embodied carbon performance objectives, and establish the performance management framework. During construction, the embodied carbon of construction materials will be measured and tracked based on the performance objectives identified in the CDCP. The result of this workshop will be the outline or framework for the CDCP (refer to **Appendix C**).

Design to Avoid New Buildings or Infrastructure

Instead of constructing a new building or infrastructure asset, consider maximizing use of the existing building structure or infrastructure.

The best way to reduce embodied carbon is through structural reuse of building components on site.[22] Evaluate whether new construction is necessary and explore the feasibility of renovation, retrofitting, or partial retention of existing structural systems. Carbon-intensive building components to consider retaining[23] when opting for partial retention of a building include flooring and the substructure.

Use BIM to Optimize Material Use/Reuse

Building information modeling (BIM) allows architects, engineers, and construction managers to make well-informed decisions by managing detailed information on building and infrastructure components (e.g. dimensions, types of concrete, quality of steel).

BIM can be integrated with LCA to achieve carbon-reduction goals by comparing design alternatives during the early design phases of construction projects. Consider using BIM for LCA comparison and selection of building materials (including reused materials) to reduce embodied carbon. BIM can be used for site and logistics management to reduce waste and transportation during construction. Digital documentation of building materials using BIM can help optimize their future use, acting as a material inventory to facilitate circularity at the building's end of life.[24, 25]

Plan for Reuse (and Remanufacturing) of Materials

Planning for material reuse requires consideration of space, transport, and future use of existing materials.

Prioritizing the reuse of building materials onsite or locally is key to avoiding carbon emissions from long-distance transport. Recognizing that space constraints can be a barrier to storing materials onsite, consider collaborating with local organizations and businesses that have the potential to provide storage and remanufacturing of building materials.

Identify upcoming local construction projects and coordinate materials exchange opportunities to maximize embodied carbon reduction while advancing the local circular economy within NYC. If local or onsite reuse is not feasible, consider other material diversion and reuse opportunities with consideration of the diminishing benefits depending on weight and transport distances. Exploring all material diversion opportunities is necessary to retain the value of existing materials, keep materials out of landfills and reduce the need for virgin resources. Material reuse should be prioritized in the following order:

1. **Reuse materials on site**
2. **Reuse materials off site within the local community**
3. **Reuse materials outside the community, but as local to NYC as possible**

Prioritize reuse of carbon-intensive materials, including metals, wood, bricks, and concrete. Examples include reusing windows and doors, remanufacturing aluminum cladding to new wall cladding, and regrading reclaimed lumber for reuse.

Plan for Material Recycling

While the greatest gains in reducing embodied carbon and waste will be captured in design, construction, and material reuse opportunities, material recycling also plays an important role.

Recycling should only be considered when a product can no longer be reused, refurbished, or remanufactured and is the only mechanism to divert potential waste from landfill.[26]

For the purposes of these Guidelines, the use of construction and demolition (C&D) materials as alternative daily cover (ADC) should be minimized and considered as a last resort. An estimate from a NYC C&D facility shows that while up to 90 percent of C&D waste can be recycled, approximately 22 percent is used for aggregate fill and up to 35 percent is used as ADC New York State issues Beneficial Use Determinations (BUDs) that allow for the use of ground C&D as ADC, but there is no formal designation of the practice as recycling. Only the BUDs that represent recycling-related uses are included in the total statewide recycling rate; BUDs for use as ADC in landfills are not. This presents an opportunity to divert more carbon-intensive materials into higher value options of reuse and remanufacturing.

Specify the Use of Reclaimed and Recycled Materials

Identifying and specifying reclaimed materials from onsite deconstruction or nearby deconstruction offers the benefits of avoided costs and carbon emissions from transport.

In addition to the suggested low-carbon materials identified in Part 1, the use of reclaimed or recycled building materials reduces the carbon emissions associated with the extraction and manufacturing of virgin materials. Carbon-intensive materials to consider specifying as reclaimed or recycled include metals and concrete. Virgin steel, for example, can have an embodied carbon footprint that is five times greater than high-recycled content steel.

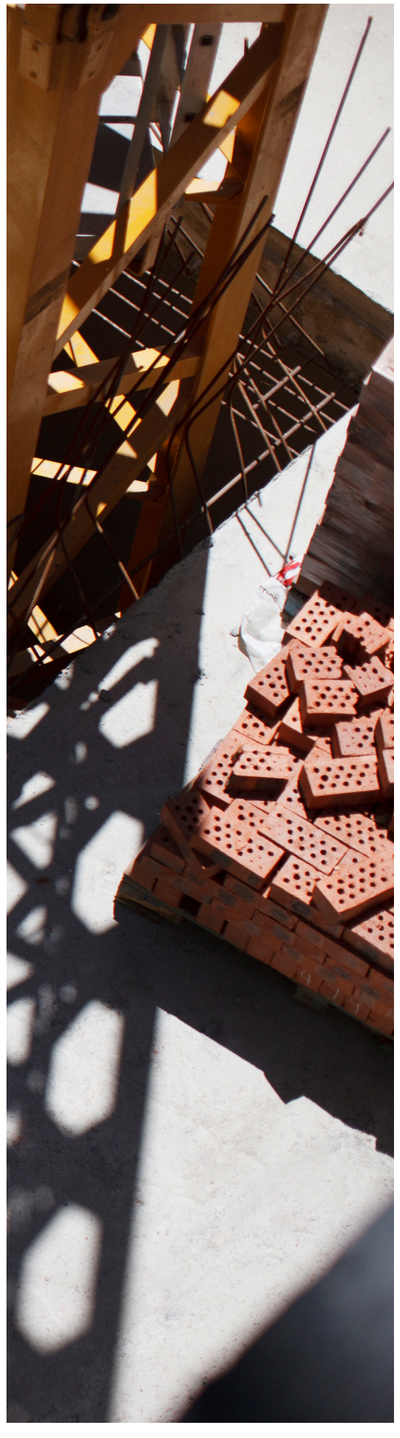
Design for Modularity/Offsite Construction of Building Components

The Design Team should consider options for offsite construction, which have been documented to reduce waste.

Modular construction can increase efficiency, as building components are prefabricated offsite in a controlled setting and then shipped to the project

Case Study: Made in New York (MiNY) Campus

The Made in New York (MiNY) Campus will provide 325,000 SF of creative manufacturing and media production space and 700,000 SF of soundphase space for film and TV in Sunset Park, Brooklyn. The MiNY campus is an adaptive reuse project, and NYCEDC will include existing elements of the structures, including wood framing and flooring, into the buildings. Excavated cobblestone and freight rail will also be used to create a pedestrian plaza.



site to be assembled. There are efficiencies in a factory environment in which material requirements are accurately (e.g. cutoffs are minimized and cycled back into the manufacturing process). Prefabrication of building components also provide the benefit of reduced time onsite for vehicles and machinery, which reduces construction time onsite and minimizes impact of construction on NYC's dense urban environment. Modular components designed for disassembly promote longevity, offering opportunities for reuse of entire modules while minimizing processing and waste generation at deconstruction.

The strategies that follow are recommendations for Asset Owner agencies and their design partners to consider when evaluating other design decisions that improve the sustainability of their assets, buildings, and facilities.

Design for Longer Life (Better Materials, Timeless Designs)

Designing for a longer life span includes applying timeless design principles (simplicity, adaptability, and flexibility) to ensure retention and longevity.

Design Teams should consider selecting high-quality durable materials based on environmental and program requirements(e.g. exterior elements that can withstand ultraviolet radiation and harsh environmental conditions). Materials that retain their value over time and allow for future reuse, such as steel, bricks, and timber, should also be considered for their reuse potential. Additionally, project teams should explore utilizing product-as-a-service systems and lease agreements instead of product ownership where possible. Product-as-a-service systems guarantee life extension through preventative maintenance, repair, and replacement as part of the service agreements.

Design for Disassembly and Deconstruction

If buildings are designed in a manner that makes them more easily deconstructed, materials reuse becomes more feasible.

To achieve maximum circularity, every phase of the lifecycle of a building or infrastructure must consider circular strategies. When circular strategies are incorporated into each phase of a project, the most value is redeemed. This includes beginning with the end activity in mind.

Design Teams should explore connections that are reversible and avoid adhesives, treatments, and finishes that prevent reuse or replacement. Bear in mind accessibility, ease, and safety for personnel who will be conducting disassembly to ensure reuse at the end of life.

Design for Materials Optimization

Designing for materials optimization means using fewer materials while maximizing performance.

Designing with fewer material inputs reduces raw materials and waste generated during construction. Design Teams should consider whether systems, components, and interior finishes typically used are necessary or efficient. Additionally, the Design Team should consider the use of high-performance products and materials to reduce dimensions of the structural components (e.g. ultra-high strength concrete, lightweight material innovations, timber-concrete composite).[27] Design options that maximize the use of space, allowing for multiple functions while avoiding space redundancies, should also be considered.

Design for Adaptability and Adaptive Reuse of Space

Adapting an existing facility to accommodate its new use should always be considered to maximize the value of existing materials.

Adaptability is the ability of a space to be modified for uses beyond the one for which it was originally designed. Designing for adaptive reuse of space considers beginning with the end activity in mind to build out the conceptual approach to the project. With the pace of change in social, economic, and physical environments, the design of new facilities should consider how they will adapt to potential changes. Design Teams should consider design features that allow for future expansion and flexibility if conditions change. Designing for adaptability and adaptive reuse will require consideration of cost, but reduces embodied carbon in the long term by minimizing the need for future demolition and /new construction. According to the AIA publication, *Buildings That Last: Design for Adaptability, Deconstruction, and Reuse*, some principles of designing for adaptability include designing with clear spans, generous floor-to-floor heights, and interior non-load-bearing partitions.

CONSTRUCTION AND RENOVATION

Phase 2 Requirements

There are many opportunities during the construction and renovation phase to implement circular strategies. This is also the phase where the initial strategies and plans identified in Phase 1 are further refined and implemented.

During Phase 2, the construction or renovation team will be required to:

- **Review the CDCP (Appendix C) that was developed in the design phase**
- **Work with the Construction SMM and CM, suggesting any necessary CDCP adjustments**
- **Provide an approach to advancing the plan object**

The CDCP should contain a description of the intended circular strategies that can be deployed during the construction phase of a project to reduce both waste and embodied carbon.

Case Study: The Highline

The Highline, a 1.45-mile -long elevated greenway in Manhattan, repurposed the original steel structure from existing railroad tracks, as well as its signature art deco railings.

Case Study: The LMCR Battery

Through the Battery Coastal Resilience Project, a coastal protection initiative to reduce flood risk as part of the Lower Manhattan Coastal Resiliency (LMCR) Project, NYCEDC has developed a robust material management strategy to inform material selection and design development and prioritize on-site reuse as much as possible.

Phase 2 Strategies

The CM Team will collaborate with the Design Team to identify the appropriate strategies that align with the project's specific vision and objectives. The following strategies provide an overview of tasks to operationalize the requirements of the CDCP and meet Guidelines' goals.

The Design Team will set targets in alignment with the Guidelines' goals and benchmark CDCP progress. The CDCP goals will be operationalized through specifications in the Contract Documents. Contractors and suppliers will be required to provide their best management practices (BMPs) and commitment statements as part of their bid documents, including any suggested adjustments to the CDCP. The CDCP will demonstrate the requirements for material reuse on site within the scope of the project and, if not feasible for reuse on site, proposals to divert and/or repurpose materials towards other end uses. This plan should detail targets for waste minimization as well as tracking mechanisms to measure targets. The CDCP should detail targets for waste minimization, identify tracking mechanisms to measure progress towards targets, and include a plan to source low-carbon materials and assess their embodied carbon performance. With a detailed plan and robust implementation, circularity can be maximized during construction.

The CDCP will**:**

- Identify the waste diversion target, specific materials that will be diverted from landfill, and their disposition strategy (onsite reuse, repurpose, recycling, or disposal)
- Identify material logistics to separate, store, and transport materials based on their disposition method
- Identify the receivers of materials that will either be deconstructed as building components for reuse/repurposing or as smaller elements for upcycling or recycling

Source Low-Carbon Materials

The Construction Manager (CM) should procure materials that can reused either onsite or locally, as identified during design.

A key component to advancing circularity in construction is thoughtful selection and sourcing of materials. This strategy begins in the Design Phase and is tracked within the CDCP to meet the Guidelines' goal of sourcing a minimum of 25 percent low-carbon materials for use within the project[28]. The Whole Building Design Guide cites that low-carbon materials will provide one or more of the following health and/or environmental attributes:

- Promote improved air quality, primarily through reduced emissions, VOCs (volatile organic compounds), and/or formaldehyde
- Require low maintenance and retain durability over time Incorporate recycled content
- Have been salvaged for reuse from deconstructed buildings or infrastructure
- Contain low embodied carbon compared to carbon-intensive materials like concrete and steel
- Avoid toxicity both in content and via their production
- Sourced locally
- Able to be reused or recycled in the future (either in its entirety or through disassembly of components)
- Capable of biodegrading at the end of their useful life

There are a growing number of web databases that offer sustainable product information and sourcing options. Examples include the US Environmental Protection Agency (EPA) Comprehensive Procurement Guideline (CPG) Program, Mindful Materials, and UL SPOT Product Database.[29]

To support low-carbon material sourcing, Environmental Product Declarations (EPDs) provide sustainable product information and will be collected and submitted to NYCEDC.

EPDs will be submitted for key construction materials (e.g., concrete, steel, iron, gypsum). For the purposes of these Guidelines and in alignment with NYC Executive Order 23, submitted EPDs will be "third party-verified International Organization for Standardization (ISO) Series 14025 Type III declaration that quantifies environmental information on the life cycle of a product to enable comparisons between products fulfilling the same function". The Design Team will manage the development of specifications and requirements for collecting EPDs, while the Construction Team manages the procurement of suppliers and EPDs of actual materials.

Implement Onsite and Local Materials Reuse

The design process will have identified what materials should be evaluated for retention or repurposing either onsite or preserved intact for use on another project or additional project elements.

Also, the Design Phase CDCP may have identified local sources of materials that can be procured for the project. The contractor and contract manager should contact the local vendors of project materials identified in the CDCP and arrange for procurement and delivery.

Commonly reused C&D materials and applications include doors, hardware, appliances, and fixtures; wood cutoffs to be used for cripples, lintels, and blocking; and excess insulation from exterior walls for interior walls as noise-deadening material. The EPA also provides a list of organizations working to reduce the disposal of construction and demolition materials, including some that provide a business directory of reuse businesses in NYC. As previously mentioned, space constraints can be a barrier to storing materials onsite; therefore, collaboration with local organizations and businesses at the construction phase is key. An important part of this strategy is to identify local construction projects and stakeholders off-site to coordinate materials exchange opportunities and ensure reuse.[30, 31]

Case Study: Red Hook Library Renovation

The Red Hook Library is being renovated by NYCEDC to expand the space by 14 percent and implement flood mitigation and protection measures. The project team will reuse the foundation, roof structure and ground floor slab and is designed to be a Net Zero Building, where total energy usage will equal energy created on-site resulting in no new GHG emissions.

Consider reuse of whole building systems and components in mass quantities and/or with high embodied carbon, including concrete, steel, wood, and bricks.

Innovative reuse/remanufacturing applications of C&D materials are emerging to further reduce the embodied carbon. The KA13 project in Oslo, Norway, set out to reuse and renovate an existing building using as many reusable elements as possible, including the load-bearing system, radiators, and repurposed components from other buildings (concrete slabs, staircases, sprinkler pipes, granite façade slabs, and wood decking, among others).

Use Material Passports

A material passport is a record of the composition of a proposed building component or structure to enable future deconstruction, reuse, and recycling.

A material passport is different than a Circularity Audit, which is an inventory of materials from an existing building. Material passports are not currently standardized, but are structured to inform sustainability decisions for a project and can also aid in determining the monetary value and condition of a structure before beginning deconstruction. Construction contractors, supplies, and manufacturers should collaborate to create material passports.[32]

DECOMMISSIONING & DECONSTRUCTION

Phase 4 Requirements

The decommissioning/deconstruction phase is a major opportunity for Design Teams to influence the circularity of a project at the end of a building or infrastructure's useful life.

During Phase 4, the Design Team may be required to perform a Circularity Audit. If new construction is needed after deconstruction, refer to Phase 1 requirements for planning and design.

Phase 4 Strategies

The following strategies should be considered when decommissioning a building to comply with CDCG goals:

Circularity Audit at Decommissioning

For projects with existing facilities, a Circularity Audit at decommissioning will enable the highest potential for materials reuse.

Whether a building will be reused, renovated, or deconstructed, the Circularity Audit when decommissioning will provide an inventory of materials (quantities and quality) that can be retained, reused, or recycled. The Design Team then can use the results of the audit to consider options that maximize the use of the existing building as part of Phases 1 and 2.

For future buildings that leverage circular design strategies from Phase 1 and circular construction strategies from Phase 2, a Circularity Audit at decommission will be less tedious, take less time, and require less investment in evaluating materials for reuse; specifically, the issuing of material passports for building components will make audits simpler and less time intensive in the future.

Consider Potential for Building Reuse

Coupled with the results of the Circularity Audit at decommissioning consider building reuse as the first option to capture whole building systems for circularity.

If whole building reuse is not practical, evaluate options for various levels of retention or rehabilitation of the building to maximize circularity while meeting requirements of the project.

Prioritize Deconstruction Over Demolition

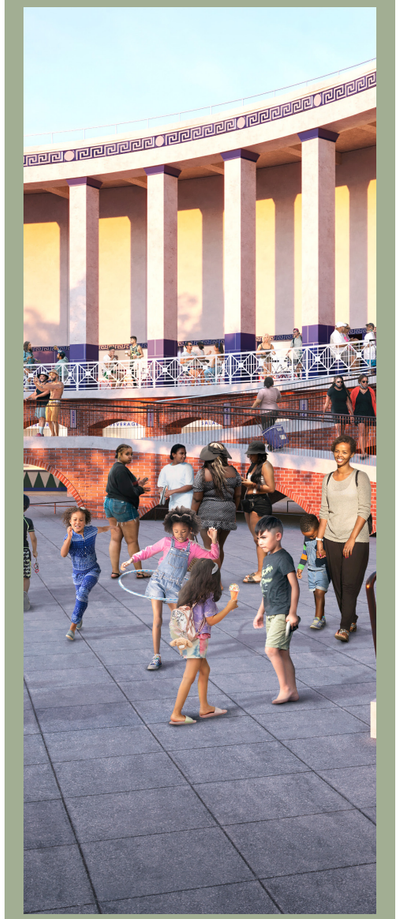
To enable the circulation of building materials at their highest value, it is time to move away from demolition and instead move toward deconstruction, a more careful and intentional recovery of used building materials.

Deconstruction will require more time and coordination, but will extend the life of valuable resources for reuse instead of prematurely disposing of them into landfills or processing them as waste. Deconstruction also has the added benefits of reduced air and noise pollution and the creation of additional jobs, as deconstruction is more labor intensive than demolition.

Costs and time associated with prioritization of deconstruction over demolition should be weighed against cost and time benefits associated with materials reuse and designing for modularity.

Case Study: The Orchard Beach Pavilion Restoration

The Orchard Beach Pavilion Restoration is a full renovation of a historic 140,000-SF bathhouse facility in the Bronx. NYCEDC is maintaining the historic character of this public space by reusing materials, including the concrete superstructure, limestone facade panels, terrazzo flooring, and ornamental metals.



WORKING TOGETHER

Circular design and construction calls for a cultural shift. NYCEDC is tacking action to facilitate this shift by requiring use of these Guidelines across its capital portfolio and using them as a tool to partner with private industry and build the technical capacity to scale circular strategies and outcomes. This is an important step in supporting NYC's goal to reduce embodied carbon emissions for new buildings, infrastructure, and major retrofits by 50 percent by 2033.

In service of this broader citywide goal, NYCEDC is advancing goals of its own through these Guidelines, which include:

- **Goal 1:** Reduce C&D waste by 75 percent for all projects
- **Goal 2:** Recycle at least 95 percent of the discarded concrete and soil generated by a construction or deconstruction project
- **Goal 3:** Ensure at least 25 percent of all materials used on a project are low-carbon materials

NYCEDC cannot achieve these goals alone. It will require deep collaboration and a willingness to work in new ways to achieve this fundamental shift in how we both design and construct buildings and infrastructure to retain the maximum value of materials and strive for a lower-carbon future.

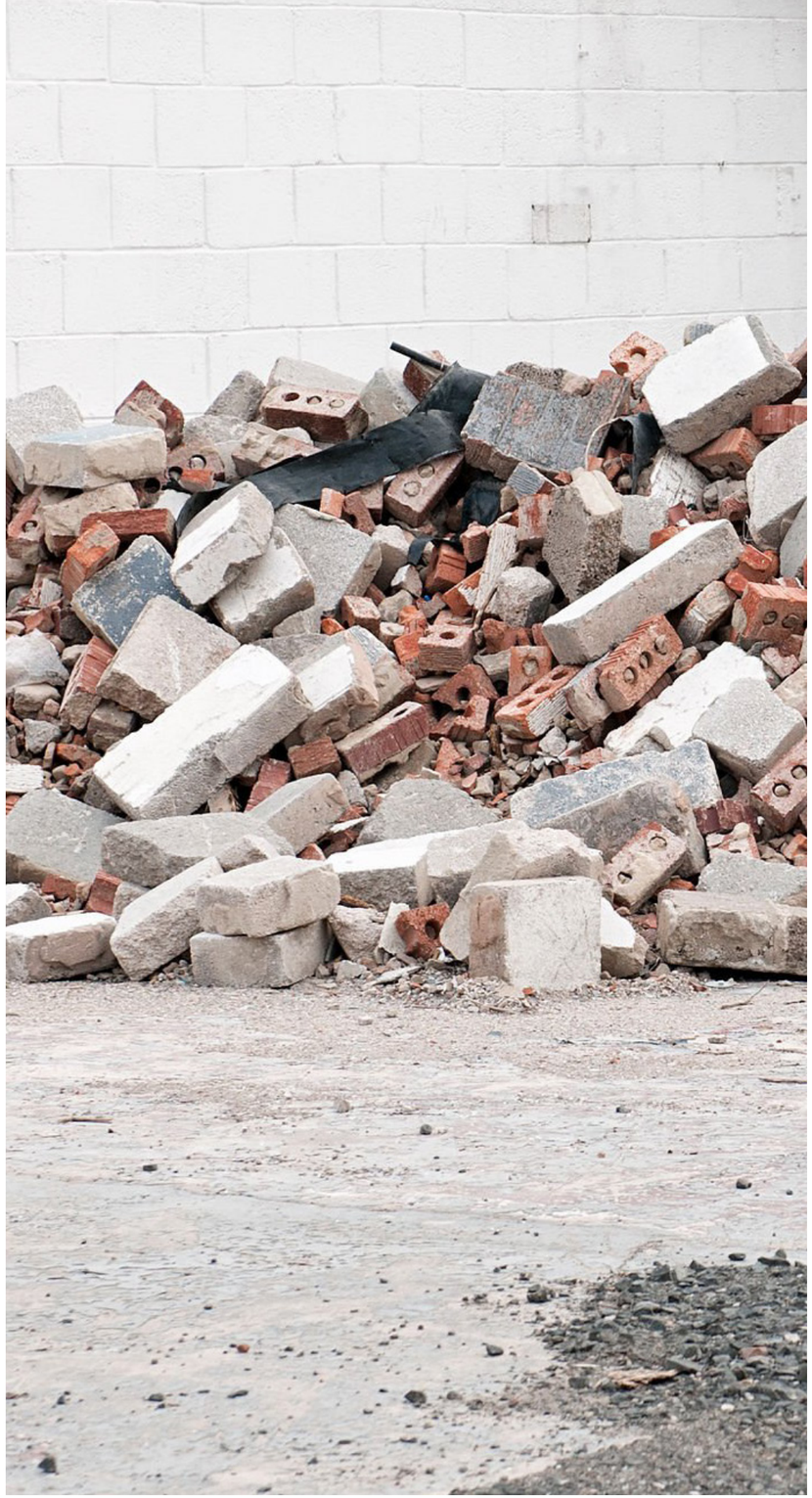
Acknowledging that this way of working is new and may require a learning curve, NYCEDC will work closely with design and construction teams to tailor implementation for each individual project and will leverage the menu of strategies provided within these Guidelines to identify which are most appropriate to pursue across a project's lifecycle.

The *Clean and Circular Design & Construction Guidelines* marks NYCEDC's initial venture to formally embed circularity into design and construction in NYC. NYCEDC will continue meeting with public and private stakeholders to gauge the effectiveness of these Guidelines, identify areas for process improvement, and scale their use.

Beginning in 2024, as project teams submit their Circular Design and Construction Plans, NYCEDC will build a data inventory to assess progress towards circular design and construction goals and will revise the Guidelines as needed to reflect lessons learned through early implementation and assist with benchmarking against NYC's embodied carbon reduction target.

Together, NYCEDC and the NYC design and construction industry can build a future in which we decarbonize our built environment by revolutionizing how it is designed and constructed.

APPENDIX A. STATE AND LOCAL POLICIES, LAWS, AND REGULATIONS



Appendix A provides a summary of existing New York State and New York City policies, laws, and regulations designed to drive material reuse and low-carbon material alternatives.

New York State Regulations

Construction and demolition (C&D) waste in New York is regulated at the state level.[33] The New York State Department of Environmental Conservation (NYSDEC) collects data from private waste haulers, transfer stations, recycling facilities, and landfills through mandated reporting requirements (NYU-CUSP 2021).

Recent New York Senate Bill S1587 addresses C&D waste and proposes a requirement for contractors in cities having a population of one million or more to recycle 50 percent of the waste generated on construction and demolition sites (NYS 2019).[34]

New York City Policies

Since the early 2000s, New York City has taken a leadership position to develop and implement policies that protect the environment and combat climate change (Figure A-1). The following section outlines the chronological order of local climate policies beginning with the first iteration of *PlaNYC* released in 2007.

- ***PlaNYC:*** A Citywide strategic plan first released in 2007 and updated in 2011 and 2023. The 2023 update, titled *PlaNYC: Getting Sustainability Done* is the fifth in a series of climate action plans released by NYC, pursuant to Local Law 84 of 2013. Under the De Blasio administration, *PlaNYC*'s scope expanded to encompass beyond sustainability to include resilience, focus on equity, and become a strategic plan for all of NYC government. *PlaNYC*: *Getting Sustainability Done* builds on these progressive scopes to acknowledge embodied carbon reductions within the City's decarbonization priorities.
- **OneNYC:** A Citywide strategic plan first released in 2015 that includes nine subject areas focused on addressing the climate crisis and improving infrastructure. OneNYC states that NYC will "create incentives and infrastructure for city businesses and consumers to use recycled materials to support the growth of closed-loop recycling ." The Plan also included a goal to send zero waste to landfills by 2030. An update to OneNYC was released on Earth Day 2023 and calls for carbon neutrality by 2050.[35]
- **New York City's Roadmap to 80x50:** A roadmap to achieve 80 percent reduction in carbon emissions by 2050, pursuant to Local Law 66 of 2014. The Plan states that, by 2050, the collection of recyclables and organic materials such as food scraps and yard waste, along with the expansion of energy and material recovery from waste, will have spurred economic activity and catalyzed the development of a citywide circular economy.[36]

The Guidelines use existing design guidelines produced in NYC for reference, including the following:

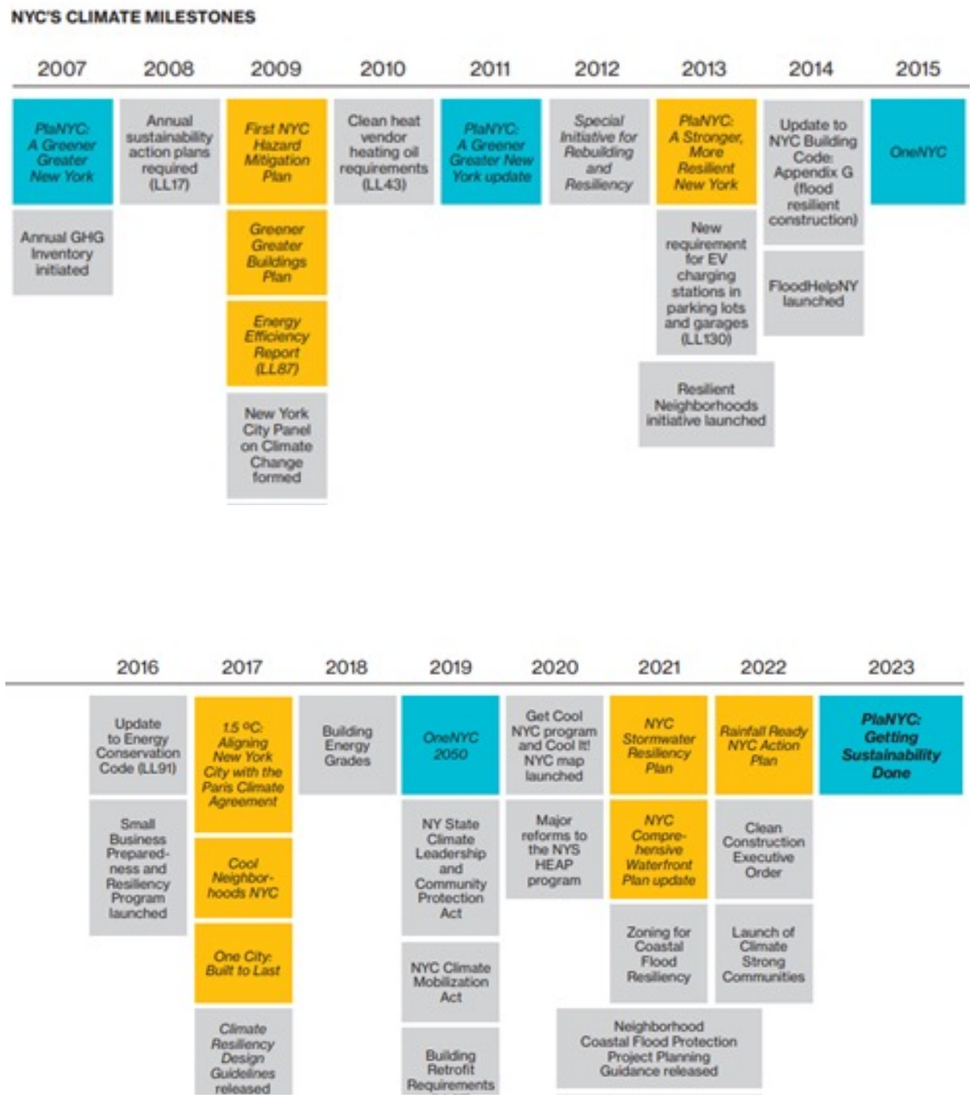
- **High Performance Building Guidelines, City of New York Department of Design and Construction (NYC DDC 1999):** Identifies strategies for C&D waste prevention and recycling, including preparing and implementing a Waste Management Plan, procedures for salvaging selected materials, and recycling C&D material. The DDC also has developed a specification for LEED projects, which requires either 50 percent or 75 percent waste recovery, depending on the level of LEED rating that is being sought.[37]
- **Construction & Demolition Waste Manual (NYC DDC 2003):** Resource handbook for C&D waste reduction, reuse, and recycling on NYC DDC projects. Includes responsibility for DDC project managers to include a C&D waste specification for all projects.[38]
- **High Performance Infrastructure Guidelines, NYC DDC (NYC DDC 2005):** Recommends best practices in infrastructure construction, including use of recycled and reclaimed materials. The guidelines recommend development of a recycled materials program and provide examples of projects with applications of recycled asphalt concrete, Portland cement aggregate, and Portland cement cementitious materials.[39]

- **New York City Environmentally Preferable Purchasing Minimum Standards for Construction Products, June 2012:** Local Laws 118, 119, 120, and 121 of 2005 require establishing standards for goods and materials purchased by NYC according to a list of environmental priorities regarding energy and water efficiency, hazardous materials, and recycled content. The resource handbook provides a list of products that may be specified in construction.

Similarly, the Guidelines complement other laws and executive orders of NYC, including the following:

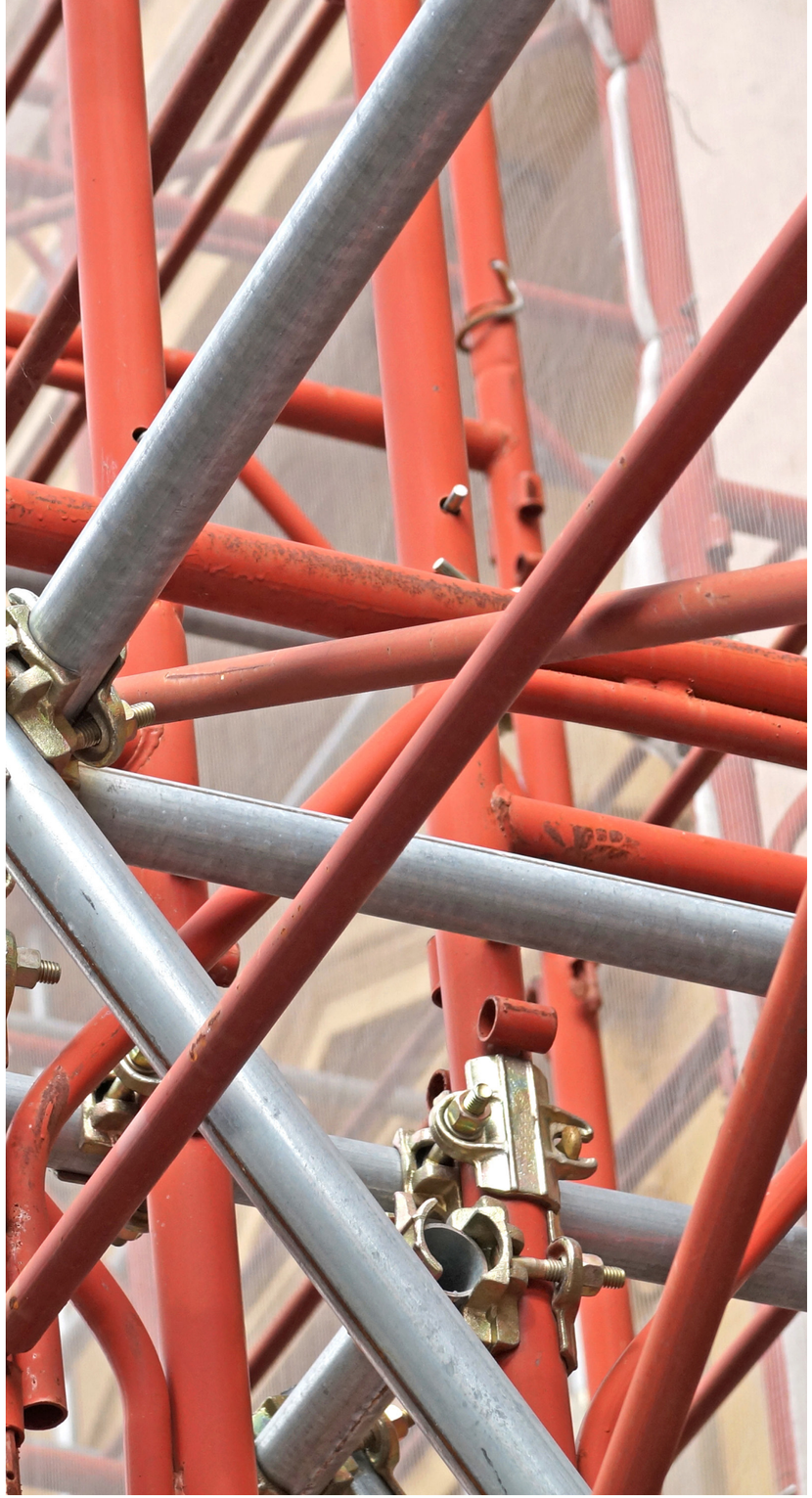
- **Executive Order 23 (2022):** An executive order that commits the City's capital project agencies to commit to actions that will lower embodied carbon, amending the City Environmental Quality Review (CEQR) Technical Manual by reducing the carbon intensity of building materials, and mandating life cycle reports and action plans for capital project agencies.5
- **Local Law 86 (2005):** NYC Green Buildings Law, which includes requirements to employ green building standards in the construction and renovation of City-owned and City-funded buildings. The law is focused on reducing energy costs and does not have specific requirements for management of C&D waste.
- **New York City Environmentally Preferable Purchasing Minimum Standards for Construction Products, June 2012:** Local Laws 118, 119, 120, and 121 of 2005 require establishing standards for goods and materials purchased by NYC according to a list of environmental priorities regarding energy and water efficiency, hazardous materials, and recycled content. The resource handbook provides a list of products that may be specified in construction contracts covered by the environmentally preferable purchasing laws.
- **Zero Waste Design Guidelines: Design Strategies and Case Studies for a Zero Waste City (2017):** Resource for designers, building operators, and planners to work toward zero waste. The guidelines promote collaboration needed to reduce construction waste and work toward implementation of circular material flows40.[40]

Figure A-1: Existing New York City Policies Climate Milestones



B

APPENDIX B. STATE OF THE INDUSTRY



Overview

Appendix B provides an overview of the state of directives driving circularity in the construction industry in the United States Based on a 2006 Northeast Waste Management Officials' Association (NEWMOA) study, the Beyond Waste: A Sustainable Materials Management Strategy for New York State (2010), and the NYC Zero Waste Design Guidelines (2017) , there are significant opportunities for recycling and reusing several categories of materials, including rock, brick, concrete, asphalt, tile, wood, soil and potentially roofing materials. Recent studies highlight the challenges and opportunities with recycling and reusing these and other materials. The NYC Zero Waste Design Guidelines identifies the anticipated percentage of high-use materials with potential reuse opportunities, as **Figure B-1** shows.

Basis of Circular Design and Construction Guideline Goals

Based on regulations from various jurisdictions and sustainable rating systems, NYCEDC has identified three initial goals for new projects to implement. Each goal is independent of the others. The initial goals are intended to be a starting point that

Table B-1. Examples of C&D Regulations Driving Circularity in the US and Canada

Jurisdiction	C&D Regulations Driving Circularity
California	The California Green Building Standards Code, CALGreen, requires at least 65 percent of C&D debris to be diverted from most new construction projects. Effective July 1, 2024, CALGreen will limit embodied carbon emissions in the construction, remodel, or adaptive reuse of commercial buildings larger than 100,000 square feet and school projects over 50,000 square feet. The new code provides three paths to compliance: reuse at least 45 percent of an existing structure, employ materials that follow prescribed emission limits, or satisfy certain performance-based criteria in a whole building life cycle assessment (demonstrating a minimum 10 percent reduction in global warming potential)[41].
Massachusetts	The Massachusetts Department of Environmental Protection (MassDEP) has implemented landfill bans on a list of C&D waste materials such as asphalt pavement, brick, concrete, metals, clean gypsum wallboard, and wood[42].
Palo Alto, CA	The City of Palo Alto enacted the Deconstruction & Construction Materials Management Ordinance, which requires deconstruction and prohibits demolition for residential and commercial projects where structures are being completely removed.[43]
Portland, OR	The City of Portland requires certain demolition projects to be fully deconstructed, instead of mechanically demolished.[44]
Chicago, IL	Chicago requires that the developer recycle at least 50 percent of the recyclable debris that is generated.[45]
Madison, WI	New construction projects that use concrete and steel support must recycle 70 percent of their construction debris by weight.[46]
Maryland	Maryland requires the sum of the recycled content and the salvaged material content will constitute a minimum of 10 percent, based on cost, of the total materials in the building project.[47]
Los Angeles County, CA	Los Angeles County is proposing to increase the minimum required C&D recycling rate from 50 percent to 70 percent; to require a 100 percent recycling rate for trees, stumps, rocks, and associated vegetation and soil from land clearing; and to require 100 percent of excavated soil for all projects be properly accounted for.[48]
San Francisco, CA	Full building demolition projects are required to recycle or reuse a minimum of 75 percent of the discarded materials generated by the project.[49]
Vancouver, BC, Canada	For homes built before 1950, a minimum of 75 percent of materials by weight must be reused or recycled.[50]

identifies opportunities that are “low-hanging fruit” and establishes the framework for data collection that is needed to create a baseline of data that can be used to refine the program as additional information is obtained. The initial goals also aim to be the driving mechanism that helps to advance the familiarity and knowledge of circular design and construction methods within the construction industry.

Table B-2 compares the CDCG goals with sustainability regulations from several jurisdictions (as described in **Table B-1**) within the US and sustainability rating systems currently used in NYC projects (LEED, Envision, and WEDG).

Figure B-1. Percentage of High-Use Materials with Potential Reuse Opportunities[40]

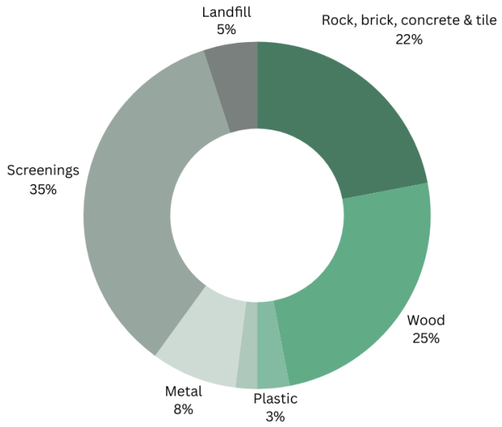


Table B-2. Examples of C&D Standards Driving Circularity in the U.S. and Canada

Metric	CDCG Goal	Other	LEED	ENVISION	WEDG
General Construction Materials Diversion	75% Overall Diversion	50%-85%	50% or 75%	25%, 50%, 75%, or 95%	Not specified
Concrete Diversion	95% Diversion	75%-95%	Not specified	Not specified	Not specified
Clean Soil and Vegetation Materials Diversion	95% Diversion	100% (from land clearing)	Excavated soil/land clearing debris are not considered C&D for LEED and excluded from diversion calculations	30%, 50%, 80%, or 100% reuse of excavated soils onsite	At least 30% or 50% of total fill material reused onsite
Recycled Content	25% low-carbon materials	10%	10%, 20% or 25%	5%, 15%, 25%, or 50%	Not specified
Embodied Carbon Reduction	25% low-carbon materials	10%	5%, 10%, or 20%	5%, 15%, 30%, or 50%	Not specified

APPENDIX C. CIRCULAR DESIGN AND CONSTRUCTION PLAN (CDCP) TEMPLATE

Instructions

This template for the Circular Design and Construction Plan (CDCP) can be used by the Design Team in collaboration with the Construction Manager and NYCEDC to create a project-specific CDCP for the Design Phase and the Construction Phase of a project. The purpose of the CDCP is to demonstrate circularity strategies in support of New York City's commitment to reduce greenhouse gas emissions by 80 percent by 2050 and send zero waste to landfills by 2030.

Circular Design & Construction Goals

As described in the NYCEDC Circular Design & Construction Guidelines, NYCEDC has identified three goals for new projects to seek. These initial goals are intended to be a starting point to identify opportunities that are low-hanging fruit, establish the framework for data collection needed to create a baseline of data that can be used to refine NYEDC's Circular Design and Construction program as additional information is obtained, and be the driving mechanism that helps to advance industry knowledge and familiarity of circular design and construction strategies.

This CDCP should be developed or updated as appropriate in each project phase, including:

- Design Phase (Design Team to develop as a work plan)
- Construction Procurement (Design Team to integrate CDCP into specifications)
- Construction Phase (Construction Manager to incorporate CDCP as work plan and to ensure project is on track to meet goals)
- As-Built (Construction Manager send as-built documents for Design Team to validate LCA and goals achievement)

As a project progresses, the CDCP will serve as a reference and iterative document to improve the overall circularity potential of a project.

Plan Elements

Project Description

Provide a brief project description including the following:

- Project name, owner, address, location, description of the project site including structures and infrastructure on site, project size and limits
- Project scope

Circularity Audit

For projects with existing assets, the results of the Circularity Audit will inform the options for materials reuse to be considered in the CDCP strategies developed in the following sections. As part of the CDCP, provide a brief summary of the Circularity Audit Report, and include the full report as an attachment.

Sustainability and Circular Design & Construction Workshops Summary

As described in the Project Workflow below (Figure C-1), Sustainability and Circular Design & Construction Workshops will be conducted during the project's Design Phase.

The result of the workshops will be the framework for the CDCP. Please provide a summary of the results of the Sustainability and Circular Design & Construction Workshops, which should include the following:

- Discussion of specific project goals/needs
- Potential circular strategies identified to achieve CDCG goals
- Results from conducting a basic estimate of embodied carbon of potential construction materials to be used (refer to Attachment A for sample resources)
- Initial embodied carbon performance objectives
- Preparation of an estimated inventory of C&D materials to be handled (type, number, utilization) and a general plan for waste minimization (refer to Attachment B for elements to consider)

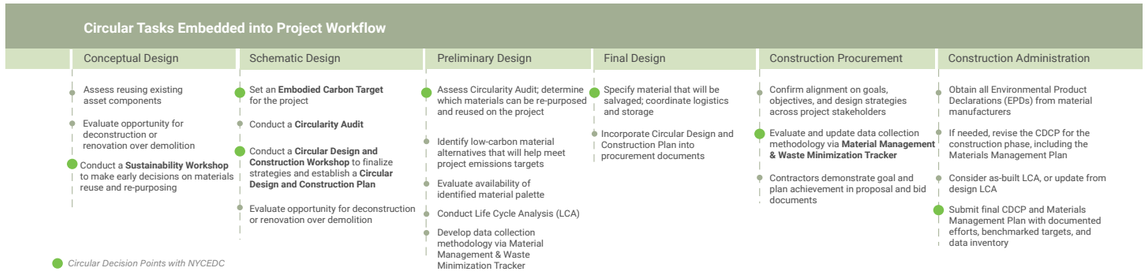
Circular Strategies

Design Phase

At the design phase of a project, the CDCP will include a narrative of the circular design strategies, including the following:

- A description of work to be performed and major circular design elements
- An assessment of strategies identified in the Sustainability and Circular Design & Construction Workshops and the selected design strategies; the Design Team can propose alternate circular design strategies if appropriate
- A summary of how the selected design strategies achieve CDCG goals
- A summary of strategies selected to be listed in **Table C-1**

Figure C-1. Project Workflow (Design Construction Projects)



Construction Phase

At the Construction Phase of a project, the CDCP will be updated by the Design Team with the following data from the Construction Manager:

- Information on sourcing of low-carbon materials such as vendor information, material purchased, quantity of material, location of source material, and location of the installation of materials.
- Environmental Product Declarations (EPDs) for procured source materials. For the purposes of The Guidelines, EPDs will be in alignment NYC Clean Construction Executive Order 23.
- Any suggested adjustments to construction strategies (update **Table C-1**, if necessary).

Table C-1

Strategy	Assessment, Recommendations, and Sourcing, as applicable
At the Design Phase, fill in information for the strategies selected. At Construction Phase, update information from design phase for implementation of strategies, as necessary.	
Design to eliminate new buildings or infrastructure when possible	
Use Building Information Modeling (BIM) to optimize material use/reuse	
Plan for reuse (and remanufacturing) of materials (with onsite or local reuse emphasis)	
Plan for recycling of materials	
Specify the use of reclaimed and/or recycled materials	
Design for modularity/offsite construction of building components	
Design for longer life span	
Design for disassembly and deconstruction	
Design for materials optimization	
Design for adaptability and adaptive reuse of space	
Source low-carbon materials reclaimed and/or recycled (collect EPDs)	
Employ onsite and local materials reuse	
Use Material Passports	
Deconstruction over demolition	
Other circular strategies (list below)	

Life Cycle Assessment

As part of the CDCP, the project should perform a Life Cycle Assessment (LCA) at the design and construction phases to identify and track areas of embodied carbon reduction.

Design Phase LCA

At the Design Phase, provide a summary and results of the LCA conducted to calculate the embodied carbon for major construction materials selected for the project, in comparison with a baseline (asset of similar size, function, orientation, location, and operating energy performance).

- Collect and review available EPDs of materials to be used on the project to better inform the LCA. Refer to Attachment A for LCA and EPD resources. EPDs to be collected will be third-party-verified ISO Series 14025 Type III declaration.
- Provide a summary of LCA results and attach documentation to include the following:
  - » Summary of building components that have high environmental impacts (hot-spot analysis)
  - » Comparative results of various design options assessed to optimize and finalize design
  - » Comparison of embodied carbon to available benchmarks to evaluate a project's performance

Construction Phase/As-Built LCA

At the construction phase, the Design Team will provide additional LCA, as applicable. The Construction Manager will provide the Design Team with data that may have significant impacts to embodied carbon values as demonstrated by the LCA. Data to be provided by CM may include:

- All EPDs of actual materials used on the project to develop the as-built LCA. As previously mentioned, in alignment with NYC Executive Order 23, EPDs to be collected will be third-party-verified ISO Series 14025 Type III declaration.

The Design Team will provide a summary of as-built LCA results and attach relevant documentation, including the following:

- Narrative comparing as-built LCA embodied carbon values from the design phase LCA
- Summary of building components that have high environmental impacts and comparison with design phase LCA
- Comparison of embodied carbon (as constructed) to updated available benchmarks to evaluate a project's performance

Material Management and Waste-Minimization Tracker

The Material Management and Waste-Minimization Tracker will demonstrate the means and methods for how waste can be avoided, reduced, reused, and/or recycled over the course of construction, in addition to how materials can be reused or repurposed on the project. The plan should also detail roles for implementation and targets for waste minimization as well as progress reports and tracking mechanisms to measure against targets.

Design Phase Material Management and Waste-Minimization Tracker

At the design phase, provide a Preliminary Material Management and Waste-Minimization Tracker (include as an attachment, if necessary) with the following considerations:

- Waste-Diversion Goals: Recycle or reuse onsite or at recycling facilities 75 percent by weight of all construction waste material and 95 percent of the following types of designated debris material: concrete and excess unrestricted soil.
- Materials Inventory: Provide a summary of estimated weight, volume, or number of C&D materials to be reused, recycled, and/or disposed of (refer to Attachment B).

- Receiving Facilities: Provide information on how and where materials will be reused, recycled, or disposed of.
- Waste Handling and Transportation: Provide information on the methods that will be used for separating recyclable materials; consider sizes of containers and designated location at the site.

As a summary, fill in the table provided in Attachment B and provide narrative (attach, if necessary) and calculations of how material management for the project will achieve NYCEDC waste-diversion goals listed previously.

Construction Phase Material Management and Waste-Minimization Tracker

At the Construction Phase, provide a Construction Material Management and Waste-Minimization Plan (include as an attachment, if necessary) and include any updates to information from the design phase (update the table from **Attachment B**). In addition to considerations from the Design Phase, include the following:

- Detailed C&D Materials Inventory: Update the materials inventory from the design phase and provide any updates to estimated volume or weight or number of C&D materials to be reused, recycled, and/or disposed of (refer to Attachment B).
- Receiving Facilities: Confirm receiving facilities identified in the design phase and provide any updates or additional details on where materials will be taken and how they will be processed (reused, recycled, disposed, etc.). In addition, update Attachment B with cost data for material reuse and disposal.
- Waste Handling and Transportation: Update information from the Design Phase with detailed information on the methods that will be used for separating recyclable waste (specify whether materials will be separated or commingled). Include information on sizes of containers, container labeling, and designated location at the site where materials separation will be located.
- Waste Haulers: Provide a list of waste haulers, including contact information.
- Roles and Responsibilities: Identify who will be responsible for collecting and tracking the information and submitting progress reports.
- Progress Reports: Submit monthly Waste-Minimization Progress Report that summarizes the previous items and tracks progress on how the project is achieving the waste-diversion goals.
- Final Report: Provide a final report detailing all major waste streams generated (minimum five materials), including disposal and diversion rates.

Circularity Summary

Provide a narrative of how CDCG goals are achieved and provide a summary in **Table C-2**.

At the final Design Phase, prepare and finalize the Design CDCP to be incorporated in specifications.

Table C-2. NYCEDC Circular Goals Achievement

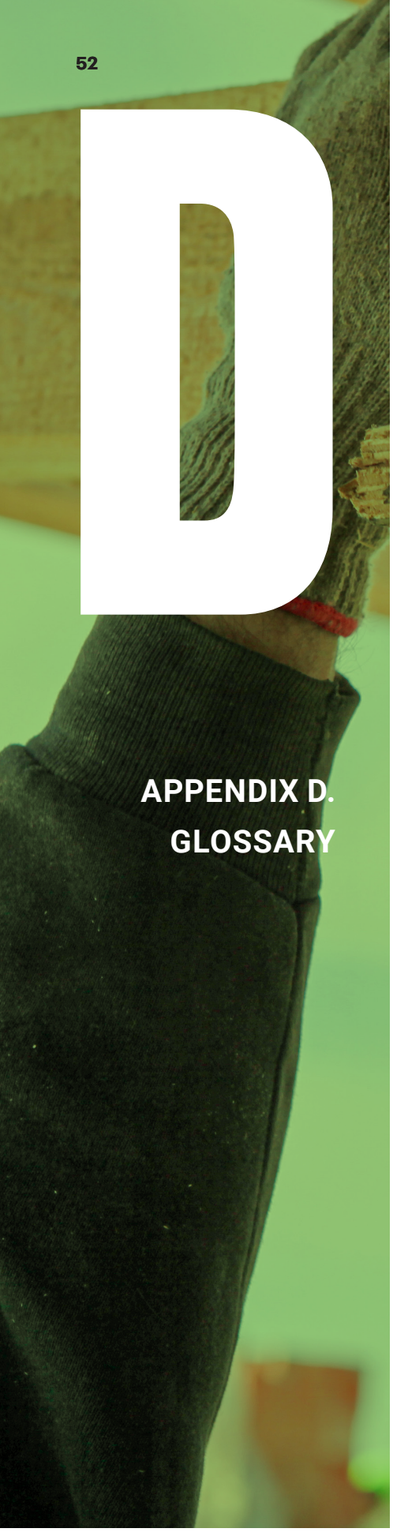
Circular Targets for Existing and New Development	CDCG Goal [a]	Goal Aiming For (%)	Goal Met?
Construction and/or Deconstruction waste materials (non-hazardous)	Minimum of 75% diverted from landfill for reuse or recycling		
Excavation soil and concrete	Minimum of 95% reuse or recycling		
Low-carbon materials or low embodied carbon materials	Minimum of 25% of the building material elements to comprise sustainable or low-embodied carbon materials		

Attachment 1. Resources to Assist in CDCP Development

- **Guidelines for the Waste Audits Before Demolition and Renovation Works of Buildings** – Published by the European Commission; provides information about the best practices for the assessment of C&D waste streams prior to demolition or renovation of buildings or infrastructure. The aim of the document is to facilitate and maximize recovery of materials and components for beneficial reuse and recycling without compromising the safety measures and practices outlined in the European Union Construction & Demolition Waste Management Protocol.[51]
- **Pre-demolition Audit: Overall Guidance Document** – This document extends the Waste Audit Guideline published by the European Commission (listed above)[52]
- **ECOM (E)mbodied (C)arbon (O)rder of (M)agnitude** – ASCE Structural Engineering Institute's (SEI) Embodied Carbon Order of Magnitude (ECOM) estimator[53]
- **CARE Tool** – The CARE Tool allows users to compare the total carbon impacts of renovating an existing building versus replacing it with a new one
- **Environmental Product Declarations (EPDs): A Guide for Architects** – Discusses EPDs in accordance with the International Standard ISO 14025 and different types of EPDs (industry wide, product specific, etc.)[54]
- **Tech Brief: Environmental Product Declarations** – An educational document by the US Department of Transportation Federal Highway Administration summarizing what EPDs are, the different types, potential uses, and additional resources[55]
- **Embodied Carbon in Construction Calculator (EC3)** – A free database of construction EPDs and building impact calculator for use in design and material procurement[56]
- **LCA Practice Guide** – Introduces the use of life cycle assessment to analyze the environmental impacts of buildings[57]
- **Athena Impact Estimator for Buildings** – Free software tool that is designed to evaluate whole buildings and assemblies based on internationally recognized LCA methodology[58]

Attachment 2. Material Management & Waste-Minimization Plan Summary Worksheet

Material Description	Material Type	Estimated Total Weight **(tons or CY)**	Estimated Percentage of Overall Project Waste	To Be Reused **(tons or CY)**	To Be Recycled **(tons or CY)**	To Be Disposed of/Landfill/ Incineration **(tons or CY)**	Separation and Storage Methods	Transport/ Hauler
At Design Phase, provide estimates and general information on weights, methods, and facilities. At Construction Phase, confirm estimates from the Design Phase and update with more detailed information (weights, methods, cost, etc.), as applicable.								
	Concrete							
	Asphalt							
	Wood							
	Metals							
	Dry Wall/ Gypsum							
	Unrestricted Soils							



APPENDIX D. GLOSSARY

Definitions

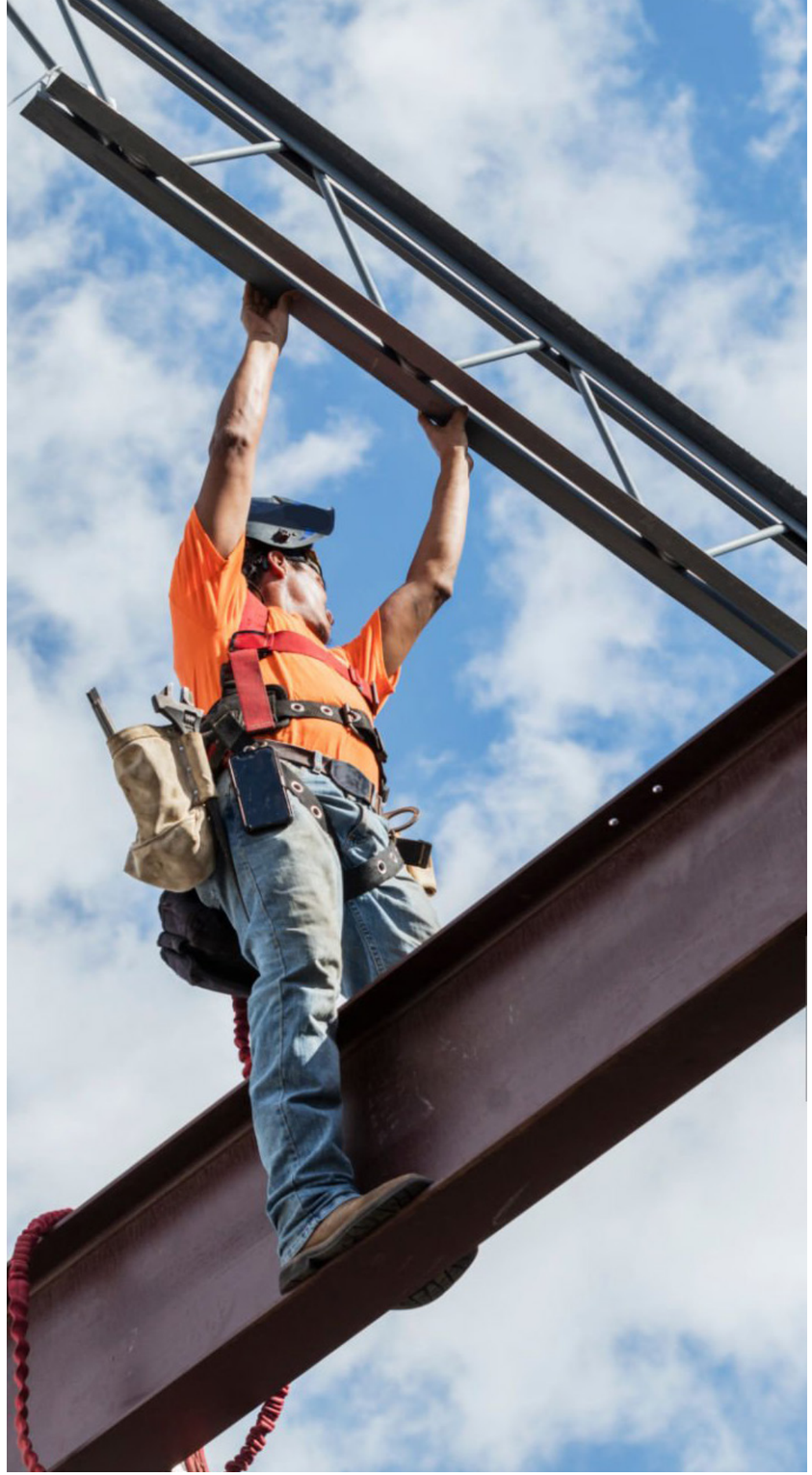
Terminology used in these guidelines is defined in the following table. Some of these definitions may vary from state or local definitions slightly; however, terms are defined to be specific to the content in this document.

Term	Definition
Alternative Daily Cover (ADC)	Cover material other than earthen material placed on the surface of the active face of a municipal solid waste landfill at the end of each operating day to control vectors, fires, odors, blowing litter, and scavenging. Federal regulations require landfill operators to use six inches of earthen material as daily cover unless other materials are allowed as alternatives. In New York, the state issues Beneficial Use Determinations that allow for the use of ground construction and demolition (C&D) debris as ADC, but there is no formal designation of the practice as recycling. For the purposes of these guidelines, the use of C&D materials as ADC should be minimized and considered as a "last resort."[59]
Building Information Modeling (BIM)	A three-dimensional (3D) digital modeling method that produces a digital representation of an asset across its life cycle, from planning and design to construction and operations. BIM can be used to manage detailed information on building components (e.g., dimensions, type of concrete, quality of steel), optimizing future uses of these materials and facilitating circularity[25].
Bio-based material	Products that mainly consist of a substance (or substances) derived from living matter (biomass) that either occur naturally or are synthesized. It also may refer to products made by processes that use biomass. Following a strict definition, many common materials such as paper, wood, and leather can be referred to as bio-based materials but, typically, the term refers to modern materials that have undergone more extensive processing.60
C&D	Construction and demolition (C&D) materials, debris, or waste is the solid waste stream that results from land clearing and excavation, and the construction, demolition, remodeling, and repair of structures, roads, and utilities.[61]
Circular economy	A circular economy keeps materials, products, and services in circulation for as long as possible. It is a change to the model in which resources are mined, made into products, and then become waste. A circular economy reduces material use; redesigns materials, products, and services to be less resource intensive; and recaptures "waste" as a resource to manufacture new materials and products. [62]
Circularity Audit	A review of an existing asset (building or infrastructure) that will provide an inventory of materials (quantities and quality) that can be retained, reused, upcycled, or recycled. The planning and Design Team then can use the results of the audit to consider options that maximize the use of the existing asset.
ConstructNYC	The ConstructNYC program is designed to connect small- to mid-sized minority/women-owned and otherwise disadvantaged business enterprises (MWDBEs) with exclusive opportunities to work on NYCEDC projects through contracts of up to $3 million.[61]
Deconstruction	The process of carefully dismantling buildings to salvage components for reuse and recycling. Deconstruction can be applied on a number of levels to salvage usable materials and significantly cut waste.[61]
Demolition	The dismantling, razing, destroying, or wrecking of any building or structure or any part thereof. [64]

Term	Definition
Disposal	Final disposition of waste materials through landfilling or an energy-recovery process involving techniques such as combustion, gasification, or pyrolysis. It should be considered as a last resort and only when materials cannot be reused, recycled, or remanufactured.[64]
Diversion	Any combination of reuse and recycling activities that reduces the volume of waste disposed of in landfills or incinerators.[40]
Embodied carbon	The sum of greenhouse gas emissions (specifically, carbon dioxide [CO2]) released during the following life cycle phases: raw material extraction, transportation, manufacturing, construction, maintenance, renovation, and end-of-life for a product or system.[6]
Envision	A system of criteria and performance objectives developed by the Institute for Sustainable Infrastructure to aid decision makers and help project teams identify sustainable approaches during planning, design, and construction of infrastructure projects that will continue throughout the project's operations and maintenance and end-of-life phases.[65]
EPD	Environmental Product Declarations (EPDs) are developed by the producers of construction materials as tools to communicate the environmental impacts of material production. In alignment with NYC Executive Order 23, Environmental Product Declaration means a third-party-verified International Organization for Standardization (ISO) Series 14025 Type III declaration that quantifies environmental information on the life cycle of a product to enable comparisons between products fulfilling the same function.[55]
Ground glass pozzolan	Produced from recycled post-consumer glass, can replace up to 50 percent of cement in concrete, dramatically reducing embodied carbon emissions.[66]
ISI	The Institute for Sustainable Infrastructure (ISI) is the organization that developed and manages Envision, a framework that encourages systemic changes in the planning, design, and delivery of sustainable, resilient, and equitable civil infrastructure through education, training, and third-party project verification.[67]
LCA	Throughout the life cycle phases of a building, emissions and other pollutants are produced and released into the surrounding environment. Life cycle assessment (LCA) helps designers evaluate the environmental consequences of different designs by comparing buildings, materials, or assemblies.[68]
LEED	Leadership in Energy and Environmental Design is a series of rating systems aimed at increasing the environmental and health performance of building sites and structures and of neighborhoods. LEED covers the design, construction, and operation of all types of buildings.[69]

Term	Definition
Linear economy	The linear economy, sometimes referred to as the take-make-waste economy, is a system where resources are extracted to make products that eventually end up as waste and are thrown away.[70]
Material passport	A record of the material composition of a building component or structure; can provide information for disassembly, material reuse, and recycling potential. In some cases, information may be combined at the building level as a bank that encompasses all materials/products contained within the building.[32]
Mass timber	A structural building material composed of engineered wood products; layers of wood joined together to form structural beams, columns, panels. Can be used as alternatives to concrete, steel, light wood frame, and masonry buildings.[71]
OneNYC	A series of strategic plans that address climate change released for New York City under the De Blasio administration.
PlaNYC	A series of strategic plans/reports issued for New York City that include actions to combat climate change. The first plan was issued in 2007 and updated in 2011, 2013, and 2023. *PlaNYC* was released under the Bloomberg and Adams administrations, whereas OneNYC was released under the De Blasio administration.[1]
Product-as-a-service	Marketing products on a subscription model, for example, including initial installation and ongoing maintenance.[7]
Product life extension	Extending the use period of existing products through repair or refurbishment.[7]
Recycling	The process of diverting discarded material from disposal, intermediate processing such as at a materials-recovery facility (MRF), and end-use manufacturing that alters the form of the secondary material to make a new product.[7]
Reuse	Using an object or material again, either for its original purpose or for a similar purpose, without significantly altering the physical form of the object or material.[62]
Salvage	The recovery of valuable or useful materials for reuse.[7]
Sharing platforms	Sharing underutilized products, reducing the demand for new purchases.
Solid waste	Garbage, refuse, sludges, and other discarded solid materials resulting from residential activities and industrial and commercial operations. Includes municipal solid waste.[3]

APPENDIX E.
ACKNOWLEDGEMENTS



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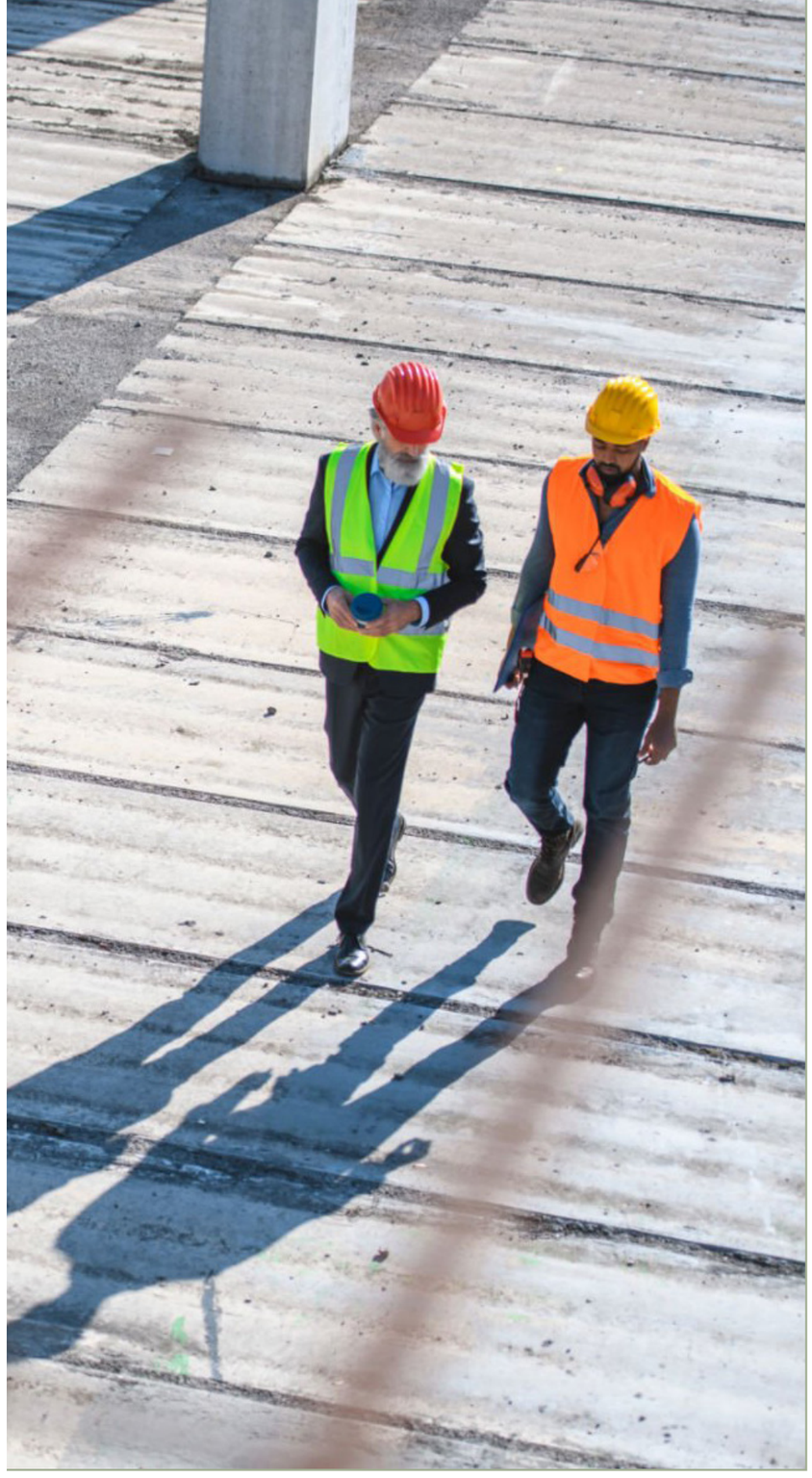

APPENDIX F.
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WORKS CITED

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