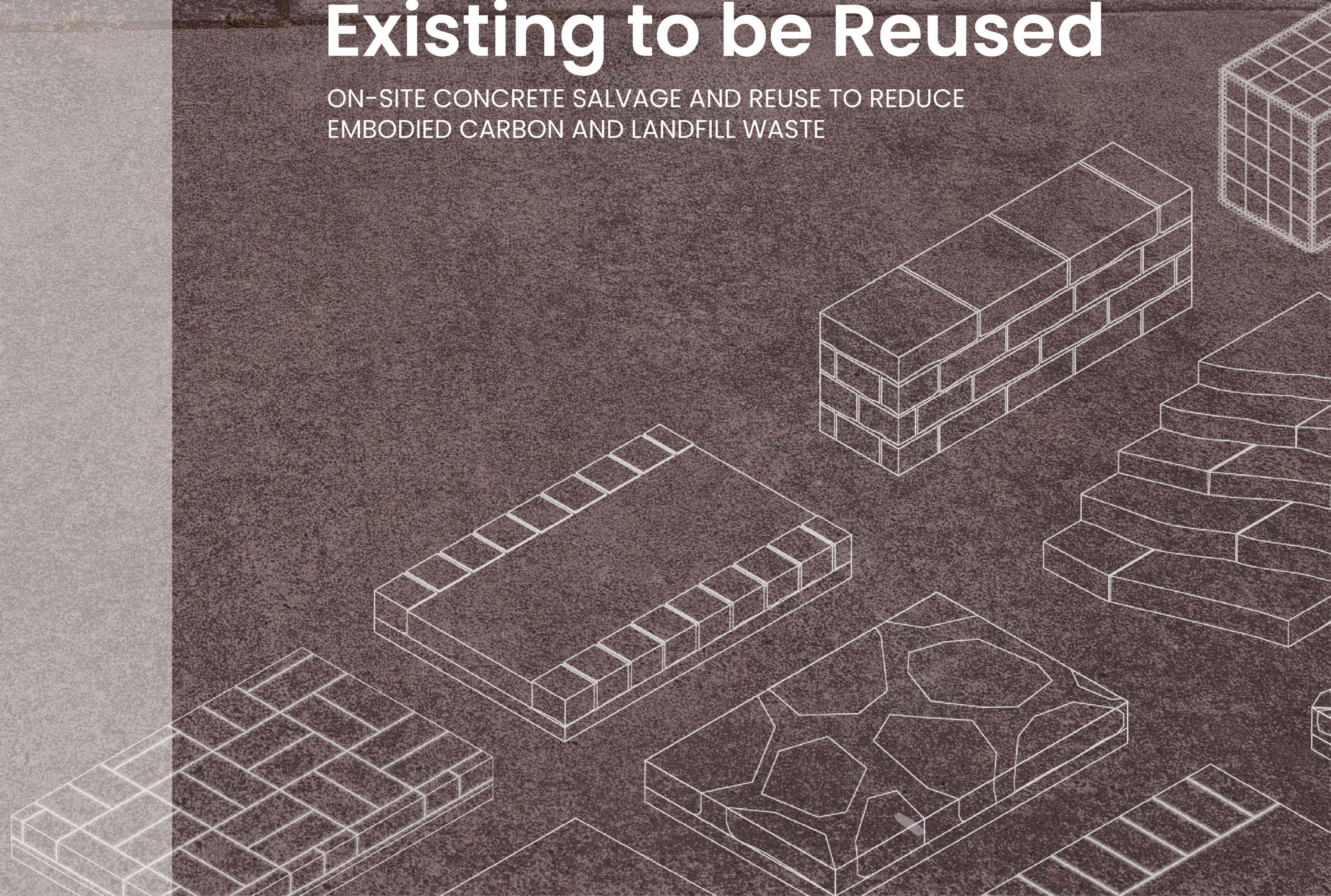


# Existing to be Reused

ON-SITE CONCRETE SALVAGE AND REUSE TO REDUCE  
EMBODIED CARBON AND LANDFILL WASTE

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2025





Thank you to my advisor Mary Polites,  
my MLA cohort, and Bruce



# ABSTRACT

This project examines on-site concrete salvage and reuse as a viable and valuable strategy for reducing embodied carbon and landfill waste in built landscapes. Although a handful of tools and guides for decarbonizing built landscapes have become available in recent years, there is a notable lack of tools specifically addressing site-scale reuse strategies. This project aims to help fill that gap, focusing on concrete, one of the landscape industry's most heavily used and highest embodied carbon materials. The project involves three sequential components: precedent analysis, reuse guide development, and design application of the guide. Landscape precedents are analyzed both quantitatively and qualitatively to understand the impacts of concrete reuse and factors motivating reuse within the industry. Findings point to different ways to advocate for reuse depending on site scale, as well as potential cost-savings opportunities for sites over 10 acres in size. Building upon findings from precedent analysis and additional research, a practical guide for on-site concrete reuse is developed. The guide presents specific reuse options for commonly found forms of concrete to serve a range of different design functions. Lastly, a comparison of speculative site design scenarios models how to use the guide in a site-specific context, in tandem with a design decision-making process centering reuse. Amidst a worsening climate crisis, this project responds to the growing imperative to do more with existing materials. It offers pragmatic guidance for concrete reuse, helping designers create built landscapes which are a net positive to both people and the environment.



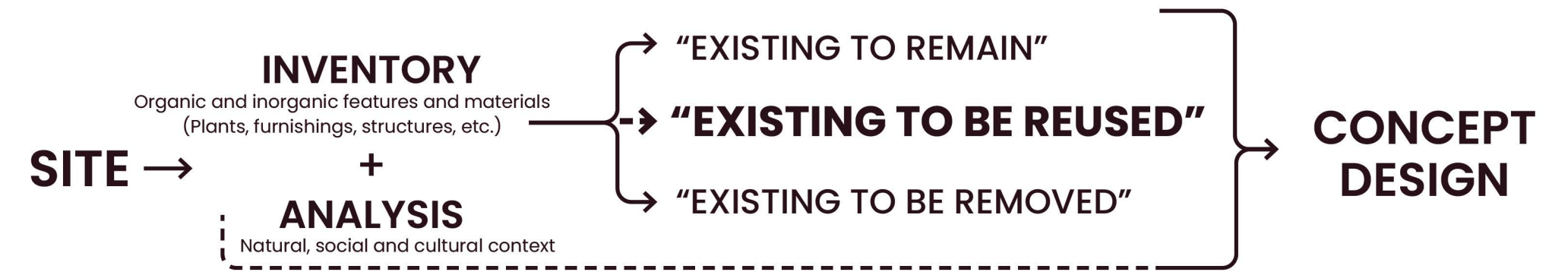




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## INTRODUCTION

### EXISTING TO BE REUSED, A SHIFT IN THINKING

When existing built landscapes are redesigned or renovated, hardscape is often demolished and removed from the site, generating landfill waste and increasing the need for new material inputs and the total carbon footprint of the project.

In the typical landscape design process, a site inventory and analysis is conducted before design work begins. The analysis investigates a range of natural and cultural factors, such as climate and soil conditions, hydrology, utility infrastructure, community context, and adjacent land uses (Design Workshop, 2015). The physical elements of the site—both built and natural—are also inventoried, then placed into two broad categories for future action: “existing to remain” and “existing to be removed.” This project proposes that a third category, “existing to be reused,” be considered as well, to foreground material reuse as an essential goal for every built landscape.

To support this revised design process, this project responds to the question: **“How can existing concrete be salvaged and reused on-site in public-facing built landscapes to reduce embodied carbon and landfill waste?”** While reuse can be applied to any type of material in any type of landscape, concrete reuse specifically offers larger potential carbon savings and waste diversion benefits than other less frequently used, lower carbon landscape materials.

### EMBODIED CARBON IN BUILT LANDSCAPES

Nearly every landscape construction project produces carbon dioxide and other greenhouse gas emissions. The majority of emissions are generated even before the construction phase begins, in the extraction of raw material resources, the manufacture of products from those resources, and their transport from factories to warehouses and job sites (Green, 2024; US EPA, 2023; Hardy and Frechette, 2023; Hardy et al., 2024; Lambert and Lewis, 2024). Together, these upstream emissions, as well as later phase emissions associated with construction and installation, maintenance, and eventual disposal, are described by the term *embodied carbon* (Lambert and Lewis, 2024; US EPA, 2023). The term embodied carbon is often used synonymously with *carbon footprint* and *embodied greenhouse gas (GHG) emissions*, although the latter term is more explicit in its inclusion of other gases in addition to carbon dioxide (CO<sub>2</sub>), like methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O), among others (C2ES, n.d.).

Cement production and fossil fuel combustion are two of the largest contributors to CO<sub>2</sub> emissions in built landscapes (C2ES, n.d.). Fossil fuel combustion, which powers most heavy machinery and transportation, also produces nitrous oxide, while fossil fuel production is a source of methane emissions (C2ES, n.d.). While landscape operation also contributes to overall GHG emissions, it has a significantly smaller impact on total emissions for most landscapes than embodied carbon (Hardy and Frechette, 2023, Green,

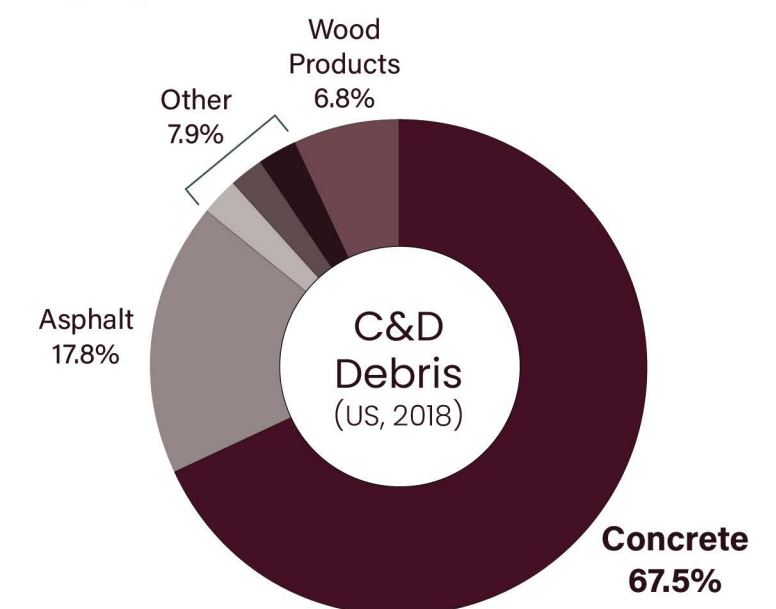
2024; Lambert and Lewis, 2024), and is beyond the scope of this project.

The ultimate source of embodied carbon in built landscapes—the demolition and removal of existing materials to off-site facilities at the end of a project’s usable life—not only requires GHG-emitting transport and equipment operation, but generates large amounts of material waste (C2ES, 2024). By salvaging and reusing previously manufactured, high carbon materials like concrete, we can significantly reduce landfill waste and the embodied carbon of our built landscapes. By salvaging and reusing concrete *on-site*, we can avoid added transportation emissions and even further reduce embodied carbon.

### DEMOLITION WASTE

In 2018, the United States produced 600 million tons of construction and demolition (C&D) debris, of which, almost 145 million tons (24%) was sent to landfills (US EPA, 2020). 67.5% of total C&D debris was concrete. Of C&D debris diverted from landfills, most became either aggregate or manufactured products (US EPA, 2020). Yet even in cases where demolished material is eventually recycled off-site, not only does the process of hauling it away produce GHG emissions, but its removal from the

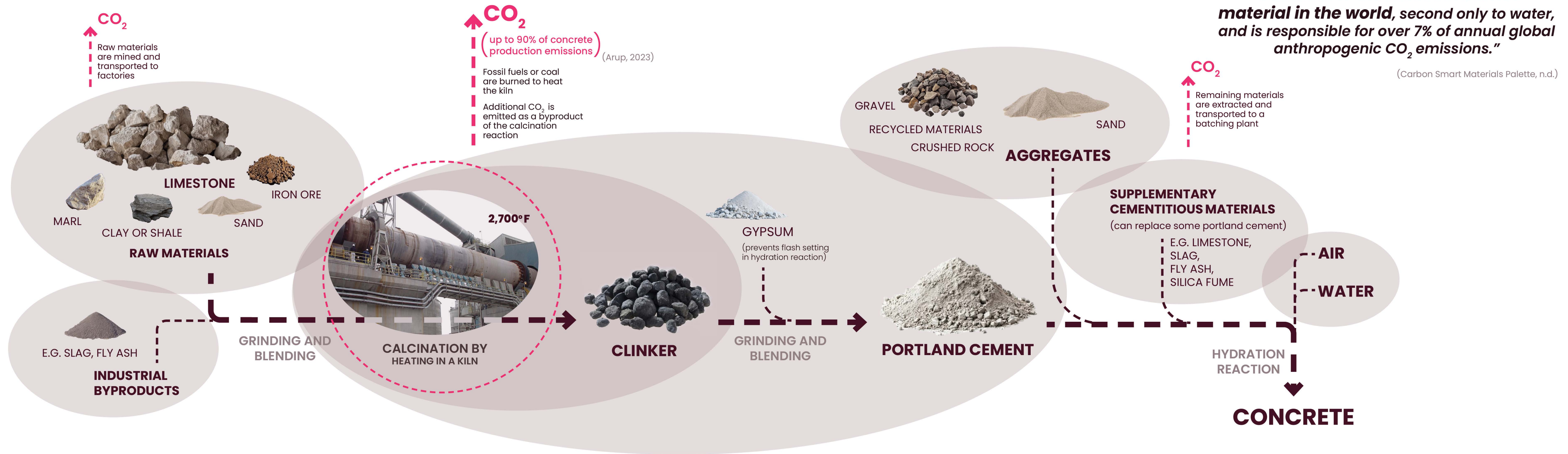
site increases the need for new material inputs to be brought in to replace it. Although estimates are not readily available for landfill contributions produced by landscape demolition specifically, it should not become an excuse for landscape architects and designers to cast off responsibility and turn a blind eye to their involvement in the construction industry. Built landscapes contain many of the very same materials as buildings and other infrastructure, including aggregates, asphalt, steel, plastics, and concrete. As reported by the EPA, concrete alone—one of landscape architecture’s most relied-upon construction materials—represented 67.5% of C&D debris produced in 2018 (US EPA, 2020). While the impact of a built landscape may be relatively small compared to that of a building or a freeway, it should not be ignored by those whose work is dedicated to designing them.











## PROBLEMS WITH CONCRETE

Concrete—the world’s most consumed material after water (Architecture 2030, n.d.a) and a widely used landscape construction material—is a major source of both embodied carbon and demolition waste. Producing the Portland cement which binds concrete not only requires large amounts of energy (usually supplied by burning fossil fuels or coal) but also releases additional carbon dioxide as a byproduct of the chemical reaction which takes place when limestone and other minerals are calcined to make clinker (NRMCA, 2008; ArchToolbox, 2025; Carbon Smart Materials Palette, n.d). **Concrete alone is responsible for 7% of annual anthropogenic CO<sub>2</sub> emissions globally** (Architecture 2030, n.d.a), and represented **67.5% of construction and demolition debris produced in the U.S.** in 2018 (US EPA, 2020). The product stage for concrete, diagrammed above,

accounts for an estimated 75% of the total embodied carbon emissions of concrete, while 15% are from installation, and 10% from end-of-life (Arup, 2023).

The UN Environment Programme and Yale Center for Ecosystems + Architecture (CEA) have suggested several mitigation strategies for reducing GHG emissions, the first of which is to “AVOID extraction and production of raw materials” by making use of existing materials instead (United Nations and Yale CEA, 2023). Likewise, the Intergovernmental Panel on Climate Change’s (IPCC) *Climate Change 2023: Synthesis Report* advocates “recycling and re-using construction materials” to reducing carbon emissions in building construction (Calvin et al., 2023, p. 105). It is reasonable to assume the same strategies could and should be applied to landscape construction as well, and that starting with concrete, the world’s most-used construction material, is a logical place to begin.

## TOOLS ADDRESSING CARBON AND WASTE

Inquiry and innovation into low and net-zero carbon construction materials and technologies over the past several decades have resulted in resources like the Carbon Smart Materials Palette and the Carbon Avoided: Retrofit Estimator tool by Architecture 2030 (Architecture 2030, n.d.a; Architecture 2030, n.d.b), the Embodied Carbon in Construction Calculator (EC3) by Building Transparency (Building Transparency, n.d.), the Athena Impact Estimator (Athena Institute, n.d.), the Environmental Performance in Construction (EPiC) Database (Crawford, 2024), various carbon calculating plug-ins for Revit (*tallyCAT*, 2022; Revit, n.d., Thornton Tomasetti, n.d.), and a slew of low-carbon concrete mix studies (Jami et al. 2019; Ingale 2021; Wasim et al. 2022; Althoey et al. 2023). These efforts have been driven largely by architecture and engineering, while landscape architecture has

lagged behind, slower to develop resources of its own (Nikologianni, 2022). Design tools created by and for architects and engineers are not always appropriate for landscape applications, and although new tools developed within just the past few years by and for the landscape design community significantly lessen this gap, more work remains to be done.

Two relatively new lifecycle assessment tools, the *Carbon Conscience* app from Sasaki Associates, now on its second version, (Hardy and Frechette, 2023), and the *Pathfinder* tool from Climate Positive Design, its third version released in 2024 (Pathfinder, n.d.), have significantly advanced the field of landscape architecture in equipping designers with tools and data to help reduce embodied emissions and increase carbon storage and sequestration throughout the design process. A Life Cycle Assessment (LCA) is a “systematic set of procedures for compiling and





## Decarbonizing the Design Process

A Phase by Phase Approach for Landscape Architects

Version 1



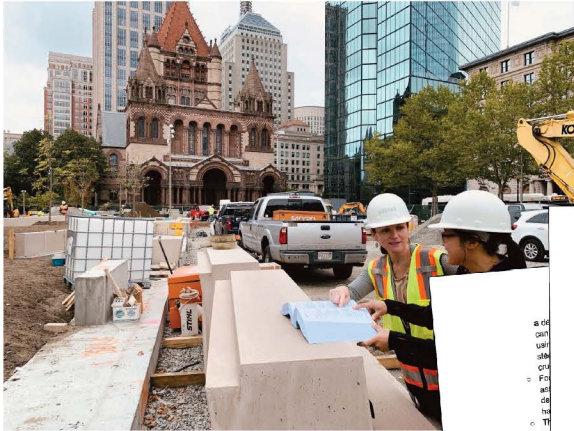
Low-carbon materials and high-sequestration planting design at Milton Street Park, Los Angeles. ASLA 2016 Southern California Chapter Meeting Award / Image courtesy of OMA Group, Irvine, California



## Decarbonizing Specifications

Guidelines for Landscape Architects, Specifiers, and Contractors

Version 1 - October, 2024



Copley Square, Boston, Massachusetts, Susati



evaluating the inputs and outputs of materials and energy, and the associated environmental impacts directly attributable to a product or process throughout its life cycle” (Lambert and Lewis, 2024, p. 6). LCA calculators allow users to sum embodied and operational carbon throughout the lifespan of their project, a predetermined number of years, often 60 (Pathfinder, 2024a; Hardy and Frechette, 2023), and then subtract the project’s potential for carbon storage and sequestration to estimate its carbon footprint. *Climate Conscience V2* and *Pathfinder 3.0* calculation tools work as compliments to each other during different phases of design.

In 2019, the non-profit organization Climate Positive Design first launched the free *Pathfinder* tool, intended to help users design landscapes which store and sequester at least as much or more carbon than they emit (Pathfinder, 2024a). *Pathfinder 3.0* calculations cover embodied carbon, operational carbon, sequestration from plants, and other environmental and social benefits (Pathfinder, 2024a). The tool is well-suited for use during the construction documentation phase, when designers can input detailed information on the specific material types and quantities they might use, to compare the impacts of different options (Pathfinder, 2024a).

Sasaki’s free *Carbon Conscience V2* app likewise

helps designers compare different design scenarios through iterative analyses, but focuses on planning, concept design, and early design development phases (Hardy and Frechette, 2023). As such, it requires planning-scale data input and proposed land uses, basing calculations on “the expected material masses for each land use’s unit area...and the types of work performed in constructing that land use” (Hardy and Frechette, 2023, p. 10). *Carbon Conscience* includes estimations for salvage and reused materials are “limited to key hardscape and aggregated items” (Hardy and Frechette, 2023, p. 52), and *Pathfinder* includes some built-in salvaged material options for users to input, but neither design tool provides specific guidance on *how* to reuse materials, and reuse has yet to be adopted as common practice within the industry.

In 2024, collaborative efforts among landscape architects, contractors, and industry professionals produced three new, high-level guides to help designers reduce embodied emissions in built landscapes (Hardy et al., 2024; Hinojosa and Ricker, 2024; Syverson-Shaffer and Anemone, n.d.). The American Society of Landscape Architects (ASLA) is the primary sponsor of these publications, two of which explicitly address material salvage and reuse. *Decarbonizing Specifications: Guidelines for Landscape Architects, Specifiers, and Contractors*



includes best practices and key principles to help reduce emissions and increase carbon sequestration, focusing on the construction documentation phase of design (Hardy et al., 2024). The guidelines recommend expanding the Existing Material Assessment (022500) section of the CSI MasterFormat specifications already used by many landscape architects to include guidelines for material salvage, testing, and preparation for reuse, as well as temporary storage and protection (Hardy et al., 2024). *Decarbonizing the Design Process: A Phase by Phase Approach for Landscape Architects, Version 1* builds upon the research foundations of *Pathfinder* and *Carbon Conscience* to provide readers with “big ideas, strategies and best practices” for reducing GHG emissions, from the earliest visioning phases of design through the ‘greenlining’ of construction details (Hinojosa and Ricker, 2024, p. 3). The document’s Concept/Schematic Design section includes a flow-chart site analysis method for assessing the reuse potential of existing materials, (Hinojosa and Ricker, 2024, originally published internally by SWA Group). Though fairly generalized, it provides a useful starting point for on-site material salvage and reuse, a necessity when no landscape is expected to last forever.

The typical lifespan of a built landscape is around thirty years (RIOS, 2019), and in some situations, it may be much shorter. Even if the landscape makes

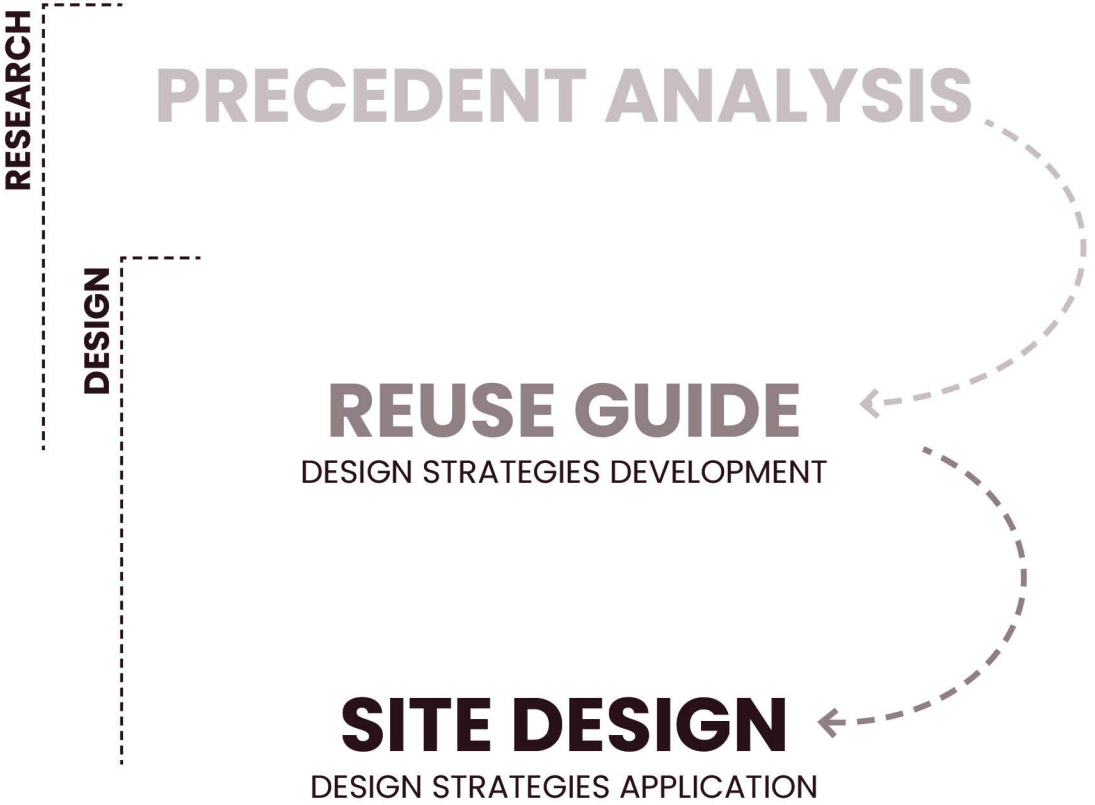
it to age sixty—the time frame used for most LCA calculations (Pathfinder, 2024a; Hardy and Frechette, 2023)—there will inevitably come a point when usage needs or desires change, or it begins to fail, and discussion will turn to redesign or renovation. At this critical point, design decisions have a significant and long-lasting impact on whether the new or renovated landscape will be a net carbon emitter, or store and sequester more carbon throughout its next lifespan than is embodied in its materials.

### PROJECT OVERVIEW

This project responds to the research question “How can existing concrete be salvaged and reused on-site in public-facing built landscapes to reduce embodied carbon and landfill waste?” through three sequential components: precedent analysis, development of a guide to on-site concrete reuse, and a case study application of the guide to site design. First, an analysis of landscape precedents examines how and why concrete has already been successfully reused in public-facing landscapes to glean lessons for future reuse. Second, building on precedent analysis findings and additional research, a guide for on-site concrete reuse is developed. Third, reuse options and strategies proposed by the guide are applied to a speculative site design as a case study demonstrating its use within a site-specific context.

## RESEARCH QUESTION:

*How can existing concrete be salvaged and reused on-site in public-facing built landscapes to reduce embodied carbon and landfill waste?*







Pete V. Domenici U.S. Courthouse Landscape Retrofit, RIOS Clementi Hale Studio, 2013

# 1. PRECEDENT ANALYSIS

## OVERVIEW

This first project component provides both a qualitative and a quantitative analysis of built landscapes which incorporate concrete reuse into their design, to understand the motivations, challenges, and achievements of concrete reuse in public-facing built landscapes, and in turn help inform the development of a concrete reuse guide.

Precedent analysis for this project required a flexible approach, as the type and quality of available documentation varied from project to project. This was especially significant for the quantitative portion of analysis which involved estimating the volume of concrete reused in each landscape. Furthermore, as each project is the result of unique, preexisting site conditions and design intentions, it can be difficult to directly compare some project-specific findings across precedents, such as carbon savings and overall environmental benefit. However, the

individual project analyses seek common metrics whenever possible, and the overall analysis methods follow industry precedent set by the Landscape Architecture Foundation (LAF) funded *Landscape Performance Series* Case Study Investigation (CSI) program. The CSI program documents the environmental, social, and economic impacts of “high performing landscape projects” (Landscape Architecture Foundation CSI, 2025). With limited and varied types of construction documentation and reporting on concrete reuse, this project—like the CSI program—worked with available data to estimate the impacts of concrete reuse as accurately as possible, recognizing the inherent limitations of this approach and the roughness of quantitative findings.

## PRECEDENT SELECTION

Precedent landscapes were selected from national ASLA professional awards and Landezine International Landscape Awards (LILA) through manual searches. Additional precedents were selected from the Landscape Performance Series Case Study Briefs by filtering search results using the tags “materials & waste,” “reused/recycled materials,” and “waste reduction,” then manually searching for instances of concrete salvage and reuse (LAF Landscape Performance series, n.d.).

All selected precedents meet the following criteria:

- **The landscape is public-facing**  
The client may be private, but the landscape itself is not associated with a private residence.
- **Previously manufactured concrete is repurposed in a visible form**  
Projects incorporating crushed concrete as base courses and fill but no visible reuse were not included because of the difficulty of quantifying subgrade material quantities with limited or no construction documentation.
- **Project construction is completed**  
Projects still in design or construction phases were not considered for this analysis.
- **The previously existing landscape was considered developed** (i.e. not a natural area)

Although performance requirements for salvaged materials may be more stringent in public-facing landscapes, such as parks, campuses, and streetscapes, the opportunity to normalize reuse through visible design elements experienced by a broad public makes focusing on these sites worthwhile. For this reason, only public-facing landscapes were analyzed. However, many lessons and specific examples of concrete reuse in these precedents are transferable to private or residential design.

In some landscapes the reused concrete was sourced from local off-site demolition rather than on-site. While this adds additional transportation-associated emissions, these precedents were still included because they provide valuable design inspiration for reuse which could be achieved on-site.

Selected precedents may repurpose other materials in addition to concrete, but calculations for those additional materials are beyond the scope of this project. It is also important to note that some landscapes incorporating salvaged concrete may have been unintentionally overlooked due to a lack of project documentation and/or search error. The precedent landscapes selected for analysis here are not presented as an exhaustive list of concrete salvage and reuse examples. In total, 8 precedent landscapes were analyzed.

## QUALITATIVE ANALYSIS METHODS

Qualitative precedent analysis sought to understand why and how designers have previously reused concrete in built landscapes, and to identify both trends and opportunities to expand and encourage reuse within the industry. Consulting written project narratives and award statements helped determine



what original forms of concrete were salvaged and (sometimes) how they were salvaged, what site elements the material became, and what design functions it achieved. These same written sources were also used to interpret what factors motivated reuse.

To compare across precedents, possible motivations were simplified into three categories: environmental, site history, and economic. Environmental motivations were limited to carbon emissions reduction and landfill waste diversion. Other environmental project goals, such as increasing permeability and reducing heat island effect—though certainly important and often related co-benefits—were not considered to have directly motivated concrete salvage and reuse. Site history motivations included adaptive reuse, preservation, and sociohistorical commentary or critique expressed through the reuse of concrete. Economic motivation included cost-savings opportunities identified by the designer and/or client resulting from the use of salvaged concrete. For each

**REUSE MOTIVATION CATEGORIES .....**

- **Environmental**  
Carbon savings and waste diversion
- **Site History**  
Adaptive reuse, historic preservation, sociohistorical commentary and/or critique
- **Economic**  
cost savings

precedent, these motivating factors or “drivers for concrete reuse” were scored on a scale from 0 to 3, 0 representing a factor that was not at all relevant to concrete reuse in the project, and 3 representing a highly motivating factor driving concrete reuse. A score of 1 indicates a somewhat motivating factor, mentioned only briefly in writings, and 2 a moderately strong motivation, mentioned multiple times in published writings and/or discussed in depth, but still less important than other drivers for reuse.

**QUANTITATIVE ANALYSIS METHODS**

The general approach to quantitative analysis across all precedents involved two broad steps. First, the volume of reused concrete was estimated in order to quantify concrete waste diverted through reuse. Specific steps taken to estimate concrete volume varied across precedents based on the type and quality of available documentation. Documentation used included site plans, construction details, photographs, Google Earth and Street View, and data from CSI Case Study Briefs in some cases as well. Waste diversion achieved off-site (for example by recycling crushed concrete at another facility) was not included. Second, GHG emissions avoided were estimated using *Pathfinder 3.0* (Pathfinder, 2024; Pathfinder, n.d.) by calculating the emissions associated with an alternative, hypothetical scenario in which new concrete was used instead of salvaged concrete to achieve a similar design outcome.

Because design intent is often multifaceted, these alternative, hypothetical situations should not be interpreted as the only possible alternative outcomes. However, they provide a useful benchmark for assessing the positive impacts of reuse in reducing emission. Emissions are expressed in kilograms of carbon dioxide equivalent (kgCO<sub>2</sub>e) and represent

the embodied emissions—including CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub>, and other greenhouse gases—associated with the product stage, transportation to the site, and construction and installation of site elements.

Estimating both waste diversion and carbon emissions avoided required establishing a set of baseline assumptions applicable to all precedents. They are likely oversimplifications of reality, but were necessary for estimating concrete quantities with limited project documentation available. General assumptions applicable to all individual precedent analyses were as follows: a) Salvaged concrete is portland cement concrete (PCC). b) Salvaged concrete was either unreinforced or separated from any previously embedded reinforcing material such as rebar or wire mesh, and embodied carbon and waste diversion estimates were calculated for concrete only. c) The weight of 1 cubic yard of unbroken concrete slab is 4,000 lb, and the weight of 1 cubic yard of broken up concrete is 2,000 lb (Calculate, n.d.). d) The impact of alternative design scenarios as calculated using *Pathfinder 3.0* assumes cast-in-place (CIP) PCC specifying type 1 or 2 cement, no supplementary cementitious materials (SCMs), and 3,000–4,000 psi strength, transported by truck from a mixing facility within a hyper-local (10-mile) radius of the site. e) When emissions are calculated for new hypothetical concrete features (“GHG emissions avoided”), the estimations do not account for embedded reinforcing materials (e.g. rebar, wire mesh, etc.), base preparation, or footings. Determining what reinforcements might be needed in each situation was beyond the scope of this analysis. f) Emissions from on-site demolition are not factored into GHG emissions avoided calculations.



### PRECEDENT SELECTION CRITERIA .....

- The landscape is **public-facing**
- Previously manufactured concrete is repurposed in a **visible** form
- Project **construction is completed**
- The previously existing landscape was considered developed (i.e. not a natural area)

### GENERAL ASSUMPTIONS FOR QUANTITATIVE ANALYSIS .....

- Salvaged concrete was portland cement concrete (PCC)
- Salvaged concrete was unreinforced or separated from previously embedded reinforcing material such as rebar or wire mesh. Carbon avoided and waste diverted are estimated for concrete only
- 1 cubic yard of unbroken concrete weighs 4,000 lb
- 1 cubic yard of broken concrete rubble weighs 2,000 lb
- Alternative design scenarios use 3,000–4,000 psi PCC made with type 1 or 2 cement and no SCMs, transported by truck from a mixing facility within 10 miles of the site

### PRECEDENT ANALYSIS EXAMPLE

**PROJECT TITLE**  
ATLANTA DAIRIES

**DESIGNER**  
PERKINS & WILL

**LOCATION**  
ATLANTA, GA

**YEAR**  
2019

**LANDSCAPE TYPE**  
URBAN OPEN SPACE

**SIZE**  
2.3 ACRES

**CLIENT**  
PRIVATE

**AWARD/RECOGNITION**  
ASLA HONOR AWARD I GENERAL DESIGN, 2019

**CONCRETE REUSE**

**QUALITATIVE ANALYSIS**

**ORIGINAL FORM AND FUNCTIONAL USE**  
LOADING-YARD PAVEMENT, FOUNDATIONS, WALLS

**NEW, REUSED FORM(S)**  
STEPPING STONE PAVERS, GABIONS, SCULPTURE

**SALVAGE METHODS (KNOWN OR ASSUMED)**  
CRUSHING AND SORTING, BREAKING (JACKHAMMERS)

**ADDITIONAL MATERIAL / PROCESSING**  
UNKNOWN

**DESIGN FUNCTIONS ACHIEVED WITH REUSED CONCRETE**

- ☒ CIRCULATION
- ☒ SEATING
- ☒ SLOPE/SOIL RETENTION
- ☒ EDUCATION (ABOUT WASTE, CARBON)
- ☒ ART (NON-FUNCTIONAL)
- ☒ HORTICULTURAL

**PRIMARY DRIVERS FOR CONCRETE REUSE**

**SITE HISTORY**  
(ADAPTIVE REUSE, HISTORIC PRESERVATION, SOCIOHISTORICAL COMMENTARY)

**ECONOMIC**  
(COST-SAVINGS)

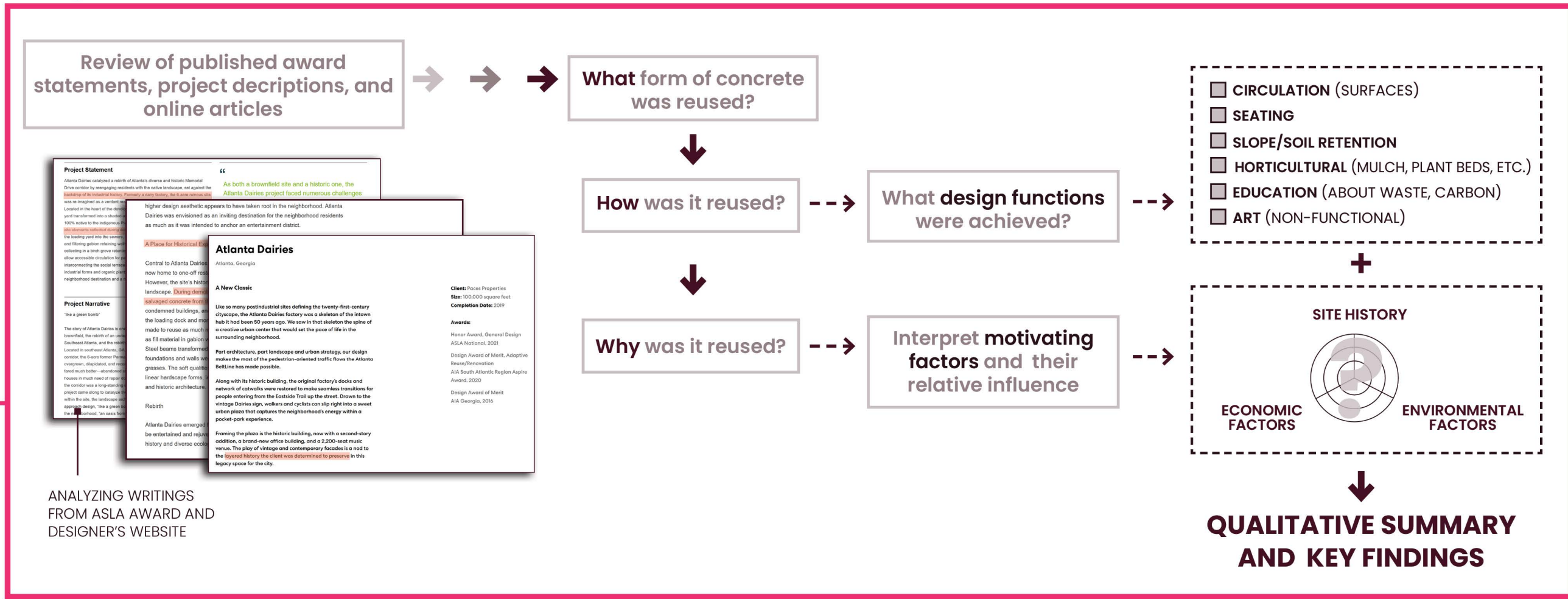
**ENVIRONMENTAL**  
(WASTE DIVERSION, CO<sub>2</sub>e)

**IN NUMBERS**

25.6 yd<sup>3</sup>  
CONCRETE WASTE DIVERTED FROM LANDFILLS BY REUSE IN GARDENS AND AS PAVERS

16,426 kg CO<sub>2</sub>e  
EMISSIONS AVOIDED THROUGH REUSE

## QUALITATIVE ANALYSIS



### REUSE MOTIVATION CATEGORIES ...

- **Environmental**  
Carbon savings and waste diversion
- **Site History**  
Adaptive reuse, historic preservation, sociohistorical commentary and/or critique
- **Economic**  
cost savings

## QUANTITATIVE ANALYSIS

### STEP 1: ESTIMATING CONCRETE WASTE DIVERTED

#### CONCRETE VOLUME ESTIMATION EXAMPLES

**ESTIMATING SALVAGED CONCRETE PAVING AREA FROM A SCALED SITE PLAN. RED HIGHLIGHTED AREAS ADDED BY AUTHOR**

**ESTIMATING SALVAGED CONCRETE SLAB THICKNESS FROM PHOTOGRAPHS. ANNOTATION BY AUTHOR**

**Using available documentation:**

- Site plans
- Google Earth
- Site photographs
- Google Street View
- Construction documents
- Published LAF *Landscape Performance Series* Case Study briefs

**Estimate surface areas and/or salvaged concrete volumes**

**Convert surface areas to volume using established assumptions**

**CONCRETE WASTE DIVERTED FROM LANDFILLS (yd<sup>3</sup>)**

### STEP 2: ESTIMATING GREENHOUSE GAS (GHG) EMISSIONS AVOIDED USING PATHFINDER 3.0

CALCULATION ASSUMES AN ALTERNATIVE DESIGN SCENARIO IN WHICH NEW CONCRETE WAS USED INSTEAD OF SALVAGED CONCRETE TO ACHIEVE A COMPARABLE DESIGN FUNCTION

**REUSED CONCRETE SITE ELEMENTS**

- BROKEN CONCRETE REUSED AS PAVERS
- REUSED CONCRETE RUBBLE GABION WALLS

**VS.**

**NEW CONCRETE WITH COMPARABLE DESIGN FUNCTIONS**

- 5" PAVING (PEDESTRIAN USE)
- CAST-IN-PLACE CONCRETE WALLS

**Estimate surface area and dimensions of site elements built with reused concrete**

**Compare to new, cast-in-place concrete elements**

**Calculate embodied carbon of new elements using Pathfinder 3.0**

**EMISSIONS AVOIDED THROUGH REUSE (kgCO<sub>2</sub>e)**





IMAGE CREDIT: SAHAR COSTON-HARDY/ PERKINS & WILL

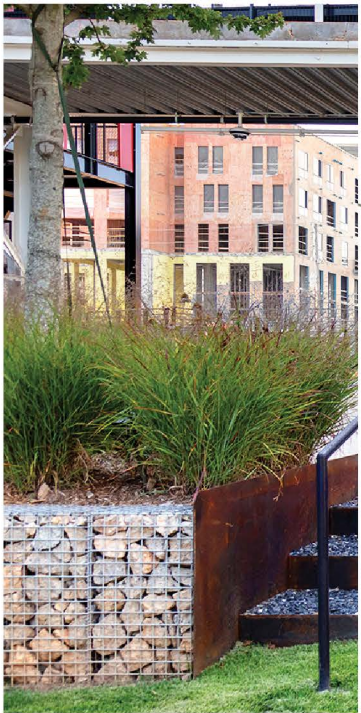


IMAGE CREDIT: SAHAR COSTON-HARDY/ PERKINS & WILL

**PROJECT TITLE**  
ATLANTA DAIRIES

**DESIGNER**  
PERKINS & WILL

**LOCATION**  
ATLANTA, GA

**YEAR**  
2019

**LANDSCAPE TYPE**  
URBAN OPEN SPACE

**SIZE**  
2.3 ACRES

**CLIENT**  
PRIVATE

**AWARD/RECOGNITION**  
ASLA HONOR AWARD |  
GENERAL DESIGN, 2019

## CONCRETE REUSE

### QUALITATIVE ANALYSIS .....

**ORIGINAL FORM AND FUNCTIONAL USE**  
LOADING-YARD PAVEMENT, FOUNDATIONS, WALLS

**NEW, REUSED FORM(S)**  
STEPPING STONE PAVERS, GABIONS, SCULPTURE

**SALVAGE METHODS (KNOWN OR ASSUMED)**  
CRUSHING AND SORTING, BREAKING

**ADDITIONAL MATERIAL / PROCESSING**  
UNKNOWN

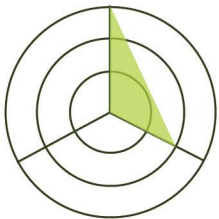
#### DESIGN FUNCTIONS ACHIEVED WITH REUSED CONCRETE

- ☒ CIRCULATION
- ☐ SEATING
- ☒ SLOPE/SOIL RETENTION
- ☐ EDUCATION (ABOUT WASTE, CARBON)
- ☒ ART (NON-FUNCTIONAL)
- ☐ HORTICULTURAL

#### PRIMARY DRIVERS FOR CONCRETE REUSE

**SITE HISTORY**  
(ADAPTIVE REUSE, HISTORIC PRESERVATION,  
SOCIOHISTORICAL COMMENTARY)

**ECONOMIC**  
(COST-SAVINGS)



**ENVIRONMENTAL**  
(WASTE DIVERSION, CO<sub>2</sub>)



IMAGE CREDIT: RIOS CLEMENTI HALE STUDIO

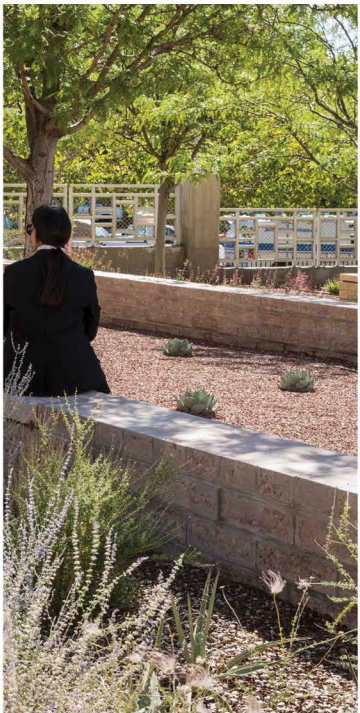


IMAGE CREDIT: ROBERT RECK

**PROJECT TITLE**  
PETE V. DOMENICI U.S.  
COURTHOUSE LANDSCAPE  
RETROFIT

**DESIGNER**  
RIOS CLEMENTI HALE STUDIO

**LOCATION**  
ALBUQUERQUE, NM

**YEAR**  
2013

**LANDSCAPE TYPE**  
CIVIC PLAZA

**SIZE**  
4.6 ACRES

**CLIENT**  
PUBLIC

**AWARD/RECOGNITION**  
LAF LANDSCAPE  
PERFORMANCE SERIES, 2014

## CONCRETE REUSE

### QUALITATIVE ANALYSIS .....

**ORIGINAL FORM AND FUNCTIONAL USE**  
SIDEWALK/PEDESTRIAN PAVING

**NEW, REUSED FORM(S)**  
MASONRY UNITS FOR LOW WALLS

**SALVAGE METHODS (KNOWN OR ASSUMED)**  
SAW CUTTING

**ADDITIONAL MATERIAL / PROCESSING**  
MORTAR

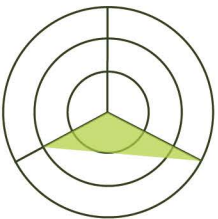
#### DESIGN FUNCTIONS ACHIEVED WITH REUSED CONCRETE

- ☐ CIRCULATION
- ☒ SEATING
- ☒ SLOPE/SOIL RETENTION
- ☐ EDUCATION (ABOUT WASTE, CARBON)
- ☐ ART (NON-FUNCTIONAL)
- ☐ HORTICULTURAL

#### PRIMARY DRIVERS FOR CONCRETE REUSE

**SITE HISTORY**  
(ADAPTIVE REUSE, HISTORIC PRESERVATION,  
SOCIOHISTORICAL COMMENTARY)

**ECONOMIC**  
(COST-SAVINGS)



**ENVIRONMENTAL**  
(WASTE DIVERSION, CO<sub>2</sub>)





IMAGE CREDIT: D.I.R.T. STUDIO

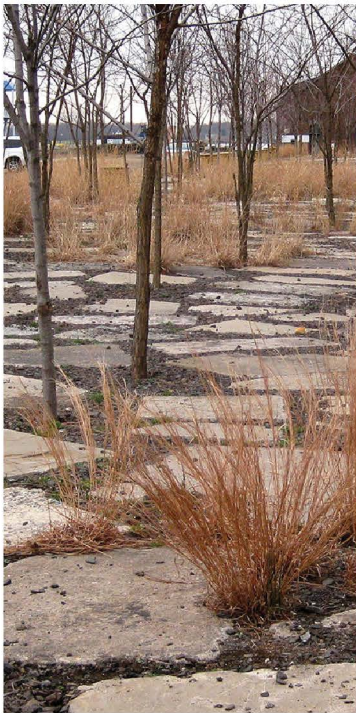


IMAGE CREDIT: D.I.R.T. STUDIO

**PROJECT TITLE**  
URBAN OUTFITTERS HQ AT THE PHILADELPHIA NAVY YARD

**DESIGNER**  
D.I.R.T. STUDIO

**LOCATION**  
PHILADELPHIA, PA

**YEAR**  
2011

**LANDSCAPE TYPE**  
COMMERCIAL

**SIZE**  
9 ACRES

**CLIENT**  
PRIVATE

**AWARD/RECOGNITION**  
ASLA HONOR AWARD, 2014

## CONCRETE REUSE

### QUALITATIVE ANALYSIS .....

#### ORIGINAL FORM AND FUNCTIONAL USE

PAVING FOR INDUSTRIAL AREA/SHIPYARD

#### NEW, REUSED FORM(S)

BROKEN SLABS SET IN AGGREGATE AS PAVERS, CRUSHED MULCH

#### SALVAGE METHODS (KNOWN OR ASSUMED)

BREAKING, CRUSHING, EXCAVATING TO REMOVE ASPHALT PAVING LAYERS

#### ADDITIONAL MATERIAL / PROCESSING

SORTING

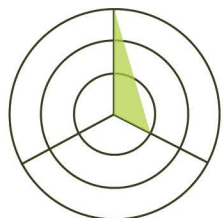
#### DESIGN FUNCTIONS ACHIEVED WITH REUSED CONCRETE

- ☒ CIRCULATION
- ☐ SEATING
- ☐ SLOPE/SOIL RETENTION
- ☐ EDUCATION (ABOUT WASTE, CARBON)
- ☐ ART (NON-FUNCTIONAL)
- ☒ HORTICULTURAL

#### PRIMARY DRIVERS FOR CONCRETE REUSE

**SITE HISTORY**  
(ADAPTIVE REUSE, HISTORIC PRESERVATION, SOCIOHISTORICAL COMMENTARY)

**ECONOMIC**  
(COST-SAVINGS)



**ENVIRONMENTAL**  
(WASTE DIVERSION, CO<sub>2</sub>)

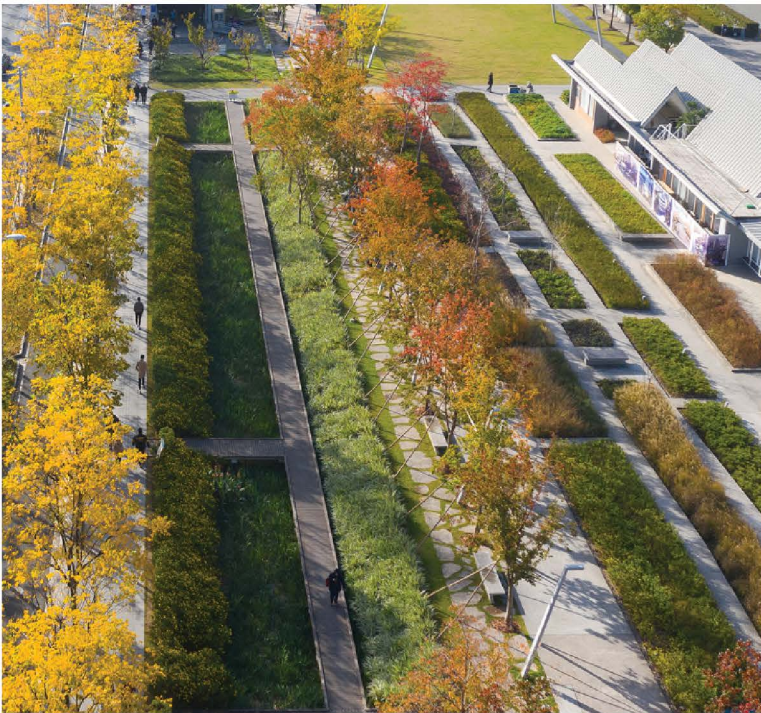


IMAGE CREDIT: INSAW PHOTOGRAPHY



IMAGE CREDIT: INSAW PHOTOGRAPHY

**PROJECT TITLE**  
XUHUI RUNWAY PARK

**DESIGNER**  
SASAKI ASSOCIATES

**LOCATION**  
SHANGHAI, CHINA

**YEAR**  
2020

**LANDSCAPE TYPE**  
PARK

**SIZE**  
36 ACRES

**CLIENT**  
UNKNOWN

**AWARD/RECOGNITION**  
LAF LANDSCAPE PERFORMANCE SERIES, 2022; ASLA URBAN DESIGN HONOR AWARD, 2021

## CONCRETE REUSE

### QUALITATIVE ANALYSIS .....

#### ORIGINAL FORM AND FUNCTIONAL USE

AIRPORT RUNWAY PAVING

#### NEW, REUSED FORM(S)

LEFT IN PLACE AS PEDESTRIAN PATH, BROKEN SLABS SET IN AGGREGATE AS PAVERS

#### SALVAGE METHODS (KNOWN OR ASSUMED)

SAW CUTTING, BREAKING, EXCAVATION

#### ADDITIONAL MATERIAL / PROCESSING

UNKNOWN

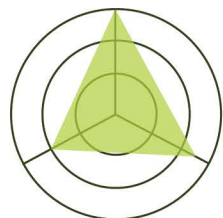
#### DESIGN FUNCTIONS ACHIEVED WITH REUSED CONCRETE

- ☒ CIRCULATION
- ☐ SEATING
- ☐ SLOPE/SOIL RETENTION
- ☐ EDUCATION (ABOUT WASTE, CARBON)
- ☐ ART (NON-FUNCTIONAL)
- ☐ HORTICULTURAL

#### PRIMARY DRIVERS FOR CONCRETE REUSE

**SITE HISTORY**  
(ADAPTIVE REUSE, HISTORIC PRESERVATION, SOCIOHISTORICAL COMMENTARY)

**ECONOMIC**  
(COST-SAVINGS)



**ENVIRONMENTAL**  
(WASTE DIVERSION, CO<sub>2</sub>)





IMAGE CREDIT: ERIC ALLIX ROGERS



IMAGE CREDIT: ERIC ALLIX ROGERS

**PROJECT TITLE**  
PALMISANO PARK / STEARNS QUARRY

**DESIGNER**  
SITE DESIGN GROUP, LTD;  
D.I.R.T. STUDIO

**LOCATION**  
CHICAGO, IL

**YEAR**  
2010

**LANDSCAPE TYPE**  
PARK, FORMER BROWNFIELD

**SIZE**  
27 ACRES

**CLIENT**  
PUBLIC

**AWARD/RECOGNITION**  
LAF LANDSCAPE PERFORMANCE SERIES, 2014

## CONCRETE REUSE

### QUALITATIVE ANALYSIS .....

**ORIGINAL FORM AND FUNCTIONAL USE**  
CITY SIDEWALKS AND FOUNDATIONS (SOURCED OFF-SITE),  
CONCRETE FENCEPOST FOUNDATIONS (ON-SITE SOURCE ASSUMED)

**NEW, REUSED FORM(S)**  
WATERFALL FEATURES, SPLASH PADS, GRADE TRANSITIONS/STEPS

**SALVAGE METHODS (KNOWN OR ASSUMED)**  
UNKNOWN

**ADDITIONAL MATERIAL / PROCESSING (KNOWN OR ASSUMED)**  
STOCKPILING BY CITY

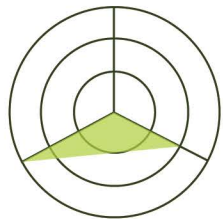
#### DESIGN FUNCTIONS ACHIEVED WITH REUSED CONCRETE

- ☒ CIRCULATION
- ☒ SEATING
- ☒ SLOPE/SOIL RETENTION
- ☐ EDUCATION (ABOUT WASTE, CARBON)
- ☐ ART (NON-FUNCTIONAL)
- ☐ HORTICULTURAL

#### PRIMARY DRIVERS FOR CONCRETE REUSE

**SITE HISTORY**  
(ADAPTIVE REUSE, HISTORIC PRESERVATION,  
SOCIOHISTORICAL COMMENTARY)

**ECONOMIC**  
(COST-SAVINGS)



**ENVIRONMENTAL**  
(WASTE DIVERSION, CO<sub>2</sub>)



IMAGE CREDIT: DE MOLFETTA STRODE



IMAGE CREDIT: DE MOLFETTA STRODE

**PROJECT TITLE**  
PICO PLAYGROUND

**DESIGNER**  
DE MOLFETTA STRODE

**LOCATION**  
LUGANO, SWITZERLAND

**YEAR**  
2022

**LANDSCAPE TYPE**  
NEIGHBORHOOD PARK

**SIZE**  
.75 ACRES

**CLIENT**  
UNKNOWN

**AWARD/RECOGNITION**  
LILA SPECIAL MENTION, 2024

## CONCRETE REUSE

### QUALITATIVE ANALYSIS .....

**ORIGINAL FORM AND FUNCTIONAL USE**  
PRECAST ARCHITECTURAL CONCRETE BLOCKS AND SLABS  
(SOURCED OFF-SITE)

**NEW, REUSED FORM(S)**  
BLOCKS AND SLABS STACKED AS CLIMBING WALLS,  
PLAYGROUND SCRAMBLES, INFORMAL SEATING; SLOPE  
RETENTION

**SALVAGE METHODS (KNOWN OR ASSUMED)**  
UNKNOWN

**ADDITIONAL MATERIAL / PROCESSING (KNOWN OR ASSUMED)**  
SAW-CUTTING, GRINDING

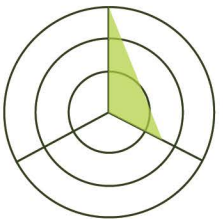
#### DESIGN FUNCTIONS ACHIEVED WITH REUSED CONCRETE

- ☐ CIRCULATION
- ☒ SEATING
- ☒ SLOPE/SOIL RETENTION
- ☐ EDUCATION (ABOUT WASTE, CARBON)
- ☐ ART (NON-FUNCTIONAL)
- ☐ HORTICULTURAL

#### PRIMARY DRIVERS FOR CONCRETE REUSE

**SITE HISTORY**  
(ADAPTIVE REUSE, HISTORIC PRESERVATION,  
SOCIOHISTORICAL COMMENTARY)

**ECONOMIC**  
(COST-SAVINGS)



**ENVIRONMENTAL**  
(WASTE DIVERSION, CO<sub>2</sub>)

### IN NUMBERS .....

**138.7 yd<sup>3</sup>**

**CONCRETE WASTE  
DIVERTED FROM LANDFILLS**  
BY REUSE AS STEPS AND WATER  
FEATURE WALLS

**61,149 kg CO<sub>2</sub>e**

**EMISSIONS AVOIDED  
THROUGH REUSE**

### IN NUMBERS .....

**149.5 yd<sup>3</sup>**

**CONCRETE WASTE  
DIVERTED FROM LANDFILLS**  
BY REUSE AS STACKED  
RETAINING WALLS, SEATING,  
AND PLAYGROUND FEATURES

**65,910 kg CO<sub>2</sub>e**

**EMISSIONS AVOIDED  
THROUGH REUSE**





IMAGE CREDIT: GARETH BYRNE



IMAGE CREDIT: DERMOT FOLEY

**PROJECT TITLE**  
BRIDGEFOOT STREET PARK

**DESIGNER**  
DERMOT FOLEY LANDSCAPE ARCHITECTS

**LOCATION**  
DUBLIN, IRELAND

**YEAR**  
2022

**LANDSCAPE TYPE**  
URBAN PARK

**SIZE**  
2.5 ACRES

**CLIENT**  
PUBLIC

**AWARD/RECOGNITION**  
LILA WINNER IN PUBLIC LANDSCAPES, 2023

## CONCRETE REUSE.....

### QUALITATIVE ANALYSIS

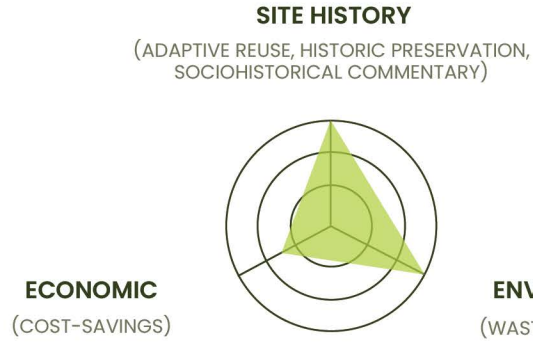
**ORIGINAL FORM AND FUNCTIONAL USE**  
VARIED URBAN DEMOLITION, SOURCED ON- AND OFF-SITE

**NEW, REUSED FORM(S)**  
INFORMAL SEATING, PAVING, SOIL RETENTION WITH INTERPLANTING, CRUSHED FILL FOR LANDFORMS, LOOSE AGGREGATE, SUB-BASES, CRUSHED AND BLENDED WITH SOILS AND OTHER SALVAGED DEBRIS

**SALVAGE METHODS (KNOWN OR ASSUMED)**  
SAW-CUTTING, CRUSHING

**ADDITIONAL MATERIAL / PROCESSING (KNOWN OR ASSUMED)**  
SORTING, BLENDING

#### PRIMARY DRIVERS FOR CONCRETE REUSE



- DESIGN FUNCTIONS ACHIEVED WITH REUSED CONCRETE**
- ☒ CIRCULATION
  - ☒ SEATING
  - ☒ SLOPE/SOIL RETENTION
  - ☒ EDUCATION (ABOUT WASTE, CARBON)
  - ☒ ART (NON-FUNCTIONAL)
  - ☒ HORTICULTURAL

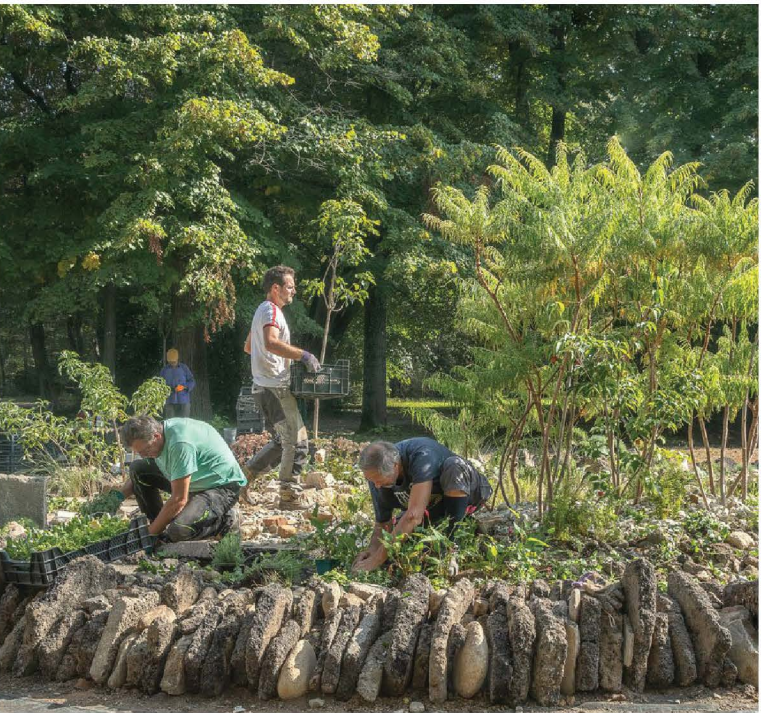


IMAGE CREDIT: YANN MONEL



IMAGE CREDIT: YANN MONEL

**PROJECT TITLE**  
STILL ALIVE!

**DESIGNER**  
WAGON LANDSCAPING

**LOCATION**  
TURIN, ITALY

**YEAR**  
2023

**LANDSCAPE TYPE**  
HISTORIC GARDEN, PARK

**SIZE**  
<1 ACRES

**CLIENT**  
UNKNOWN

**AWARD/RECOGNITION**  
LILA SPECIAL MENTION, 2024

## CONCRETE REUSE.....

### QUALITATIVE ANALYSIS

**ORIGINAL FORM AND FUNCTIONAL USE**  
DEMOLITION MATERIAL OF UNKNOWN OFF-SITE SOURCE

**NEW, REUSED FORM(S)**  
ROUGHLY BROKEN UP PIECES OF RUBBLE FORM A "ROCKERY" PLANTING BED, MULCH

**SALVAGE METHODS (KNOWN OR ASSUMED)**  
UNKNOWN

**ADDITIONAL MATERIAL / PROCESSING (KNOWN OR ASSUMED)**  
MANUAL SORTING AND PLACEMENT

#### PRIMARY DRIVERS FOR CONCRETE REUSE

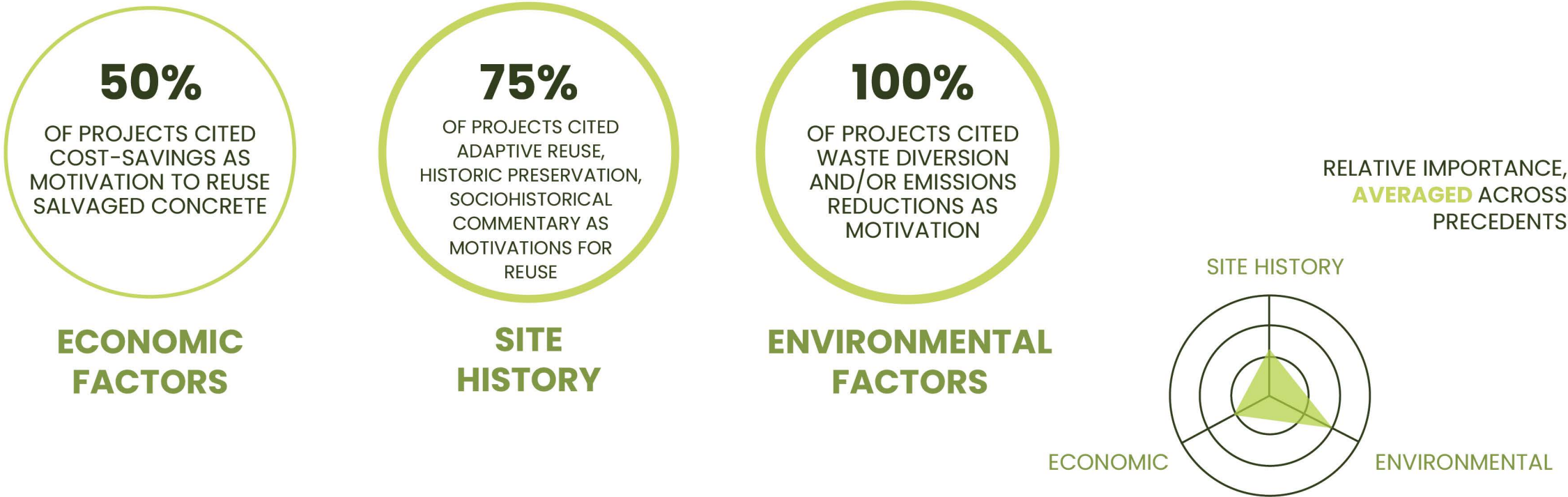


- DESIGN FUNCTIONS ACHIEVED WITH REUSED CONCRETE**
- ☐ CIRCULATION
  - ☐ SEATING
  - ☐ SLOPE/SOIL RETENTION
  - ☐ EDUCATION (ABOUT WASTE, CARBON)
  - ☒ ART (NON-FUNCTIONAL)
  - ☒ HORTICULTURAL



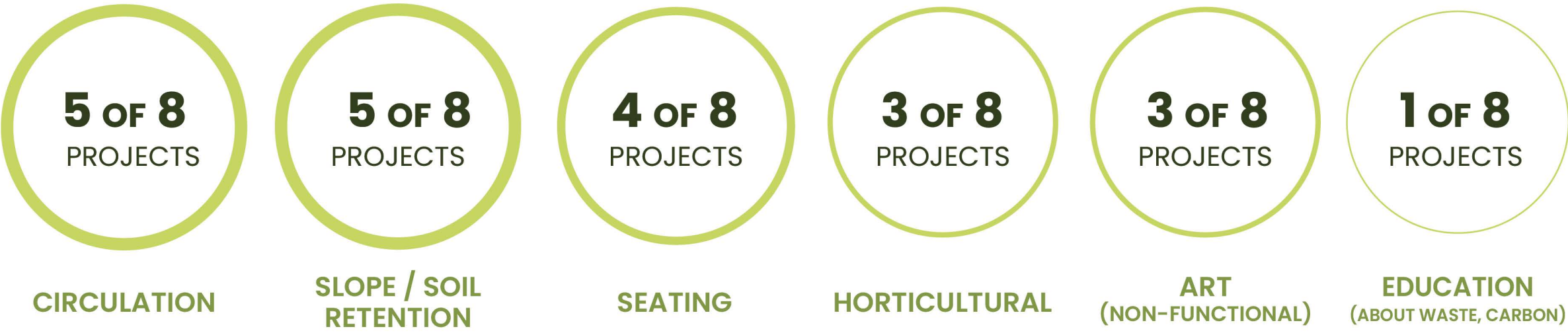
WHAT DRIVES CONCRETE REUSE?

OVERALL, CONCRETE REUSE WAS DRIVEN MOST STRONGLY BY INTENT TO **REDUCE LANDFILL WASTE** AND **GREENHOUSE GAS EMISSIONS**



WHAT DESIGN FUNCTIONS DOES IT ACHIEVE?

**CIRCULATION** AND **SLOPE / SOIL RETENTION** WERE THE MOST COMMON DESIGN FUNCTIONS ACHIEVED THROUGH REUSE ACROSS ALL PRECEDENTS



HOW DOES SITE SCALE INFLUENCE CONCRETE REUSE?

FOR THE **SMALLEST SITES**, REUSE WAS DRIVEN MOST STRONGLY BY **SITE HISTORY**.  
FOR THE **LARGEST SITES**, REUSE WAS DRIVEN MOST STRONGLY BY **ECONOMIC FACTORS**.



SUMMARY AND KEY FINDINGS

Overall, salvaged concrete was reused most often for circulation and slope/soil retention. Averaged across all precedents, the strongest and most commonly cited motivation for reuse was waste diversion and emissions reduction (together categorized as “environmental”). However, there were notable differences in motivation across precedents. Although the sample size is too small to draw definitive, industry-wide conclusions, some interesting trends emerged between site size and factors driving reuse. Neither site under 1 acre cited economic motivations (cost-savings) for reuse, while both sites over 10 acres did. Furthermore, for those larger sites (10+ acres), cost savings was the strongest influence on reuse. For the smallest sites, historical factors (adaptive reuse, historic preservation, and/or sociohistorical commentary) were by far the most important. For sites between 1 and 10 acres, site history and environmental factors were equally important. Two out of four projects in this middle size range cited economic factors driving reuse, but the economic motivation for these projects was much less substantial than for the largest sites over 10 acres.

These findings likely reflect the viability of reuse at

different site scales due to logistical complications of salvaging, processing, and temporarily storing concrete intended for reuse, as described in *Decarbonizing Specifications* by Hardy et al. (2024). The authors note that “sites over 10 acres can easily justify the temporary location of heavy equipment, such as concrete crushers and portable mills,” while “sites under 1 acre generally require more surgical reuse strategies” (Hardy et al., 2024, p. 20). Even when examining only the subset of analyzed precedents in which salvaged concrete was sourced partially or fully from off-site locations (Palmisano Park/Stearns Quarry, Pico Playground, Bridgefoot Street Park, and Still Alive!), the correlation between economic motivation and site scale remains. This suggests that for reused concrete sourced both on- and off-site, as site size increases, logistical complications become much easier to address, and reuse presents greater cost-saving opportunities.

When considering carbon impact, for very small sites (<1 acre) limited space may require salvaged material to be temporarily stored or processed off-site, resulting in transportation emissions that may offset some or all of the potential carbon savings achieved through reuse. It is logical then that for sites

under 1 acre, the driving motivation for reuse is much more strongly related to site history than to either environmental or economic factors.

In applying these findings to practice, making the most persuasive case for salvage and reuse of existing concrete will depend heavily on the size of the site. For the very smallest sites, appealing to historical preservation and adaptive reuse to honor or reveal site history, or opportunities to comment on socio-historical topics through visibly reused material, may be the most compelling ways to persuade a client the cost is justified. While carbon savings may be relatively small for these sites, salvaged material reused as featured, visible design elements in even small public spaces could help the broader public understand and embrace the importance of reuse. For sites between 1 and 10 acres, designers can easily make a case for both environmental benefits and honoring site history through reuse, and possibly cost-savings as well. For sites over 10 acres, designers may be able to present their clients with significant cost-savings made possible through concrete salvage and reuse, in addition to the social and environmental benefits achievable at smaller site scales. At all site scales, material reuse diverts waste from landfills.



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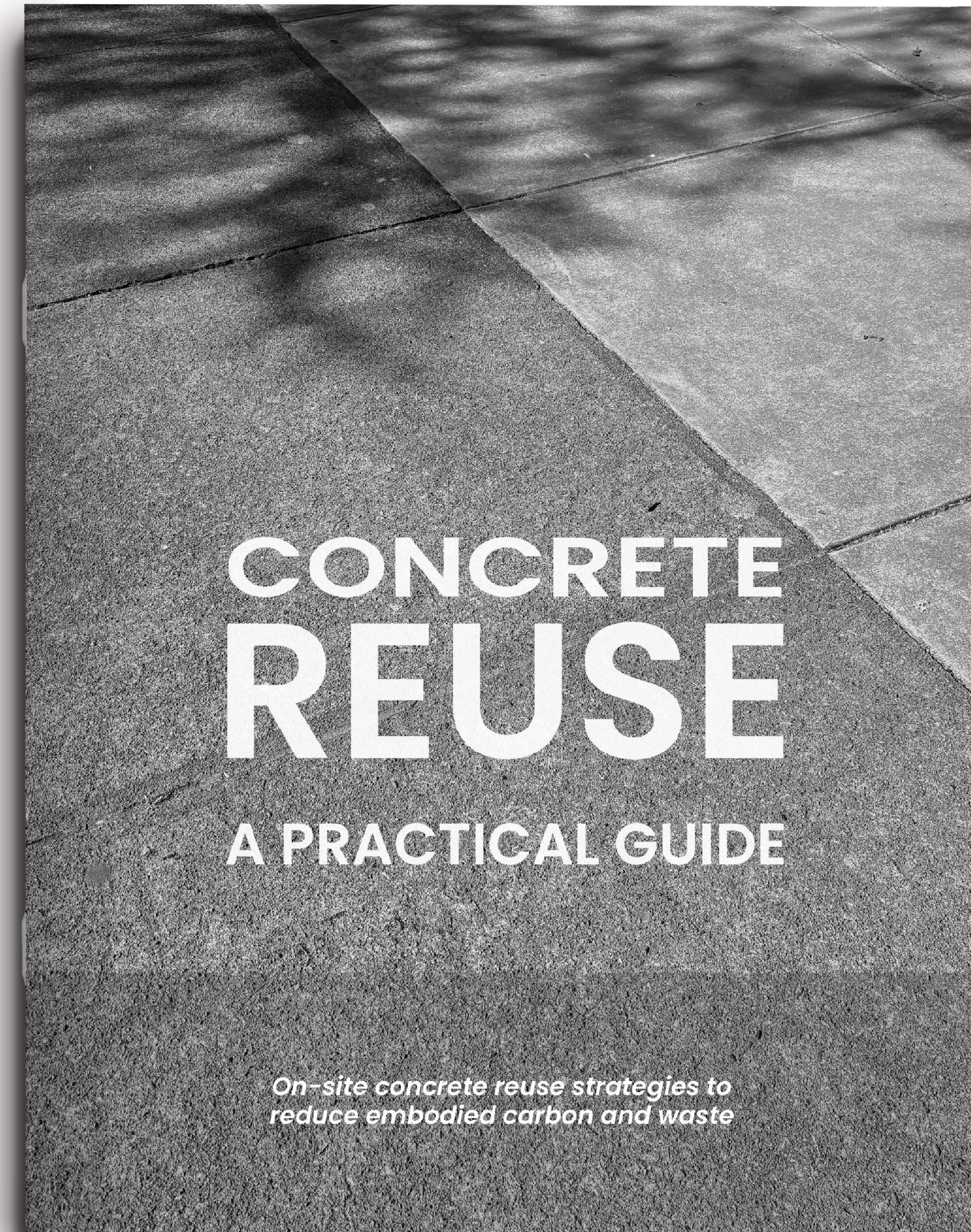
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## 2. ON-SITE CONCRETE REUSE GUIDE





PURPOSE OF THE GUIDE

This guide provides a practical introduction to site-scale, on-site concrete reuse, by presenting a range of different reuse options for commonly found forms of concrete. The creativity of designers is limitless, and reuse options are likewise limitless. This guide does not pretend to be a comprehensive menu of all possible reuse options, but rather it serves as a foundational starting point. Grounded in pragmatism, it aims to demystify concrete reuse in public-facing built landscapes. The reuse options suggested by the guide draw from precedent analysis, conversations with construction and concrete industry professionals and designers, and existing published resources addressing decarbonization and material reuse in built landscapes and construction.

Reuse options presented in the guide respond to common practical considerations of public-facing landscapes, where material performance, accessibility, and cost often receive greater attention than in private or residential landscapes. The guide aims to inspire users by illustrating the wide range of on-site reuse possibilities available even when working within such constraints, and describes key material testing and performance requirements for doing so.

HOW TO USE THE GUIDE

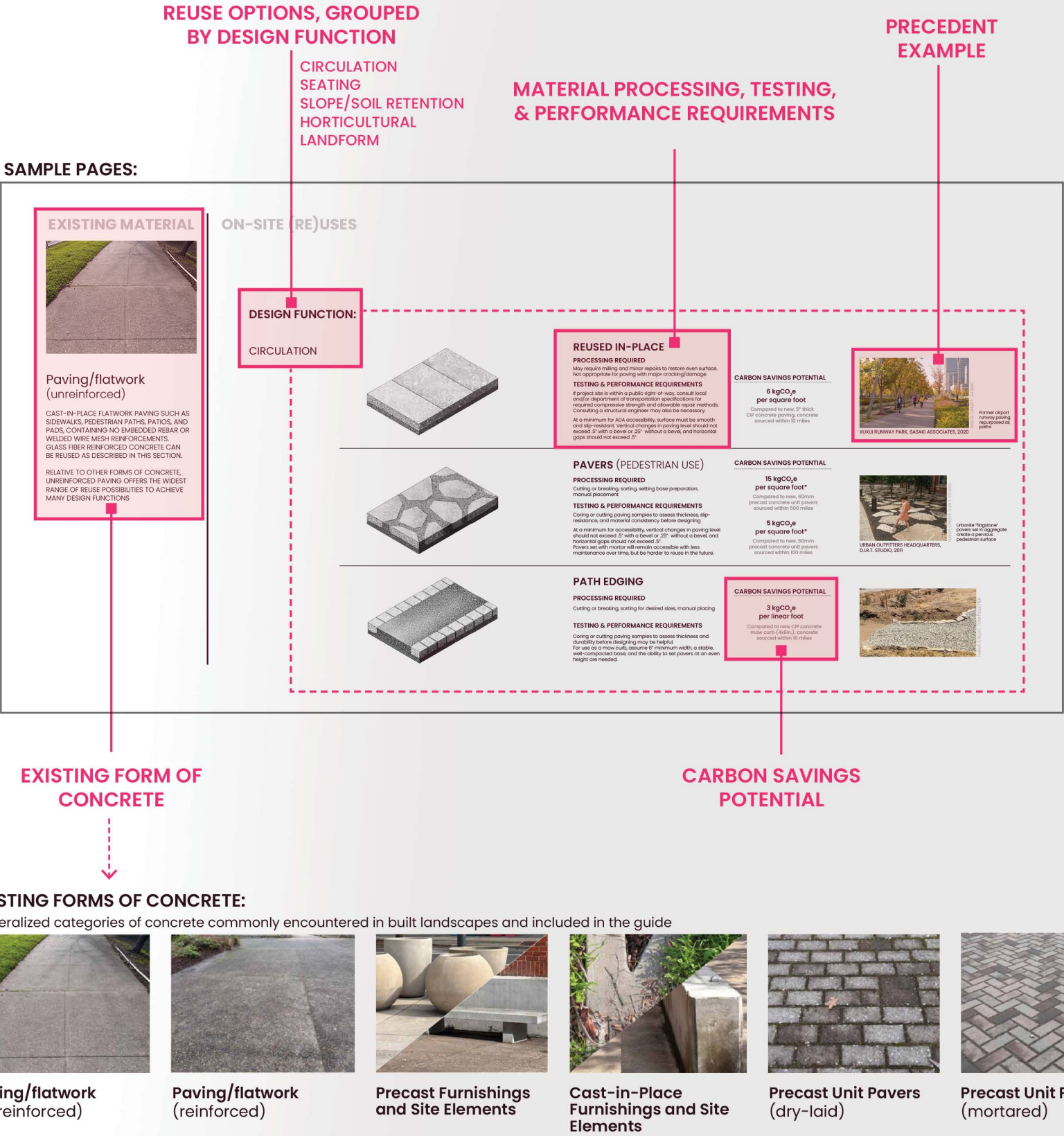
The reuse guide is organized like a product catalog, but instead of presenting new products, it presents landscape site elements built from salvaged concrete. The guide is divided into sections for different forms of existing concrete (“Existing material”), generalized and limited to those most commonly encountered in

built landscapes: unreinforced and reinforced cast-in-place paving/flatwork, precast furnishings and site elements, cast-in-place furnishings and site elements, and both dry-laid and mortared precast unit pavers.

Each existing material section is then subdivided into reuse options grouped by basic design function. These design functions are similarly simplified to reflect common landscape needs: circulation, seating, slope/soil retention, and horticultural uses. Within each section are specific options for concrete reuse which meet those design functions. Each reuse option includes an overview of the key processing, testing, and performance requirements involved, and, when possible, a quick look at potential carbon savings compared to a comparable design scenario using new concrete or other new materials instead.

Of course, each landscape situation is unique and may present challenges and opportunities not addressed in this guide, but the hope is that the guide nevertheless provides a valuable resource for those looking to learn more about what can be done with existing concrete, and a head-start in their design process. Like many current published design tools aimed at decarbonizing and improving the sustainability of our built landscapes, this guide should be viewed as a living document, not a final manual. Through future efforts it could be expanded to include reuse strategies for additional forms of existing concrete and landscape design functions, and eventually, expanded to include other materials beyond just concrete as well.

For reuse options marked with an asterisk (\*) see note on recycled concrete aggregates and leachate pH at the end of the guide.





WHEN TO USE THE GUIDE

This guide will be most useful early in the concept and schematic design phases, and best coordinated with an existing materials inventory and assessment to estimate the specific qualities and quantities of existing concrete on-site. For students in an academic setting, this will likely involve some level of assumption and rough estimation. In a real-world design, the inventory and assessment should also include testing such as core drilling or cutting of samples to measure thickness and determine whether concrete is reinforced, investigation of how concrete elements are assembled, compressive strength tests, and an assessment of material damage and wear, among others.

CARBON SAVINGS POTENTIAL

Carbon savings potential for on-site reuse options was calculated using the lifecycle assessment tool *Pathfinder 3.0* by Climate Positive Design (Pathfinder, 2024). The savings compare the difference in greenhouse gas emissions between reusing existing concrete on-site and bringing new materials to the site instead for the same functional purpose. Carbon savings potential is expressed in kilograms of carbon dioxide equivalent (kgCO<sub>2</sub>e) per unit of measure, generally one square foot or one cubic foot. These emissions reflect the sum of product stage, transportation, and construction/installation stage emissions, and do not include any emissions associated with the use or end-of-life stages.

For adjustable *Pathfinder* calculation variables, all forms of cast-in-place concrete were assumed to be transported by truck from a mixing facility within a 10-mile radius of the site ("hyper-local") as

this is often possible in reality. For other materials, transport distances to the site were chosen to reflect a likely scenario. While increases or decreases in transportation distance can have a significant impact on embodied emissions, quantifying these impacts is beyond the scope of the guide. In all calculations, the *Pathfinder* Transportation Option was set to "truck," the number of replacements over 60 years was set at 0, and the highest impact concrete type was chosen (typical 3,000–4,000psi type 1 or 2 Portland cement concrete with no SCMs). With lower-carbon concrete mix designs, shorter transportation distances, low-emissions transportation, and lean design, actual carbon emissions for new concrete could be much lower than those presented in the guide. The carbon savings in the guide are rough estimates of savings, meant to be used as a quick reference only, to aid users in understanding the relative benefits of different reuse options. They should not be used for actual project carbon accounting.

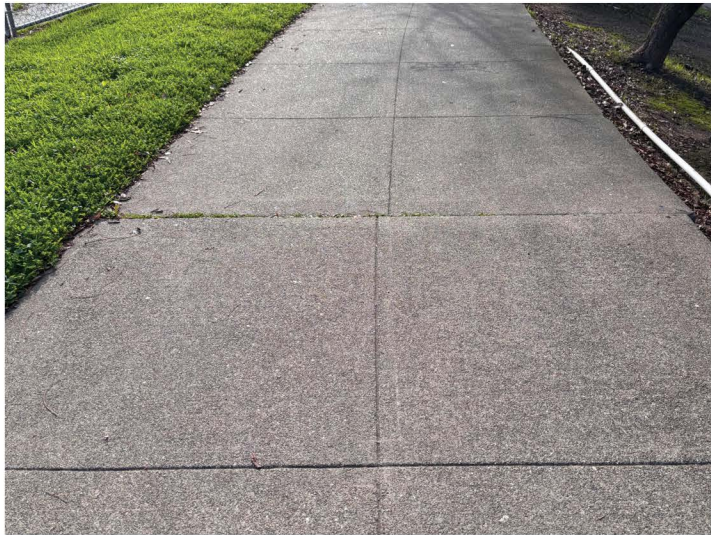
SITE SCALE AND ON-SITE CONCRETE REUSE

The viability of reuse options included in the guide depend largely on site scale. Observations by Hardy et al. in *Decarbonizing Specifications* (2024), corroborated by precedent analysis findings of this project, suggest that on-site salvage and reuse can be more difficult and costly for very small sites (under 1 acre), where there is limited space available for machinery operation and temporary material storage during construction. On-site material salvage and reuse becomes much more viable as site size increases, and for sites over 10 acres in size, there may even be significant cost savings opportunities. When on-site concrete reuse is not possible, off-site recycling should be specified in the demolition plan.

|                     | <1 acre                                                                                                                                                            | 1–10 acres                                                                                                                                                                              | 10+ acres                                                                                                                                                                      |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CHALLENGES          | <ul style="list-style-type: none"><li>Temporary storage and machine operation very difficult</li><li>High cost</li></ul>                                           | <ul style="list-style-type: none"><li>Somewhat limited space for machinery and storage</li><li>Might be costly</li></ul>                                                                | <ul style="list-style-type: none"><li>Convincing a client to embrace an unfamiliar design process and aesthetic</li></ul>                                                      |
| BEST REUSE OPTIONS  | <ul style="list-style-type: none"><li>Manual salvage and installation</li><li>Reuse in-place or reuse as-is</li></ul>                                              | <ul style="list-style-type: none"><li>Most reuse options possible with careful planning for equipment staging and material storage</li></ul>                                            | <ul style="list-style-type: none"><li>Flexible reuse options</li><li>The less processing, the greater the carbon savings</li></ul>                                             |
| ARGUMENTS FOR REUSE | <ul style="list-style-type: none"><li>Waste diversion</li><li>Site history</li><li>Public education about reuse benefits</li><li>Possible carbon savings</li></ul> | <ul style="list-style-type: none"><li>Waste diversion</li><li>Site history</li><li>Public education about reuse benefits</li><li>Carbon savings</li><li>Possible cost savings</li></ul> | <ul style="list-style-type: none"><li>Waste diversion</li><li>Site history</li><li>Public education about reuse benefits</li><li>Carbon savings</li><li>Cost savings</li></ul> |



## EXISTING MATERIAL



### Paving/flatwork (unreinforced)

CAST-IN-PLACE FLATWORK PAVING SUCH AS SIDEWALKS, PEDESTRIAN PATHS, PATIOS, AND PADS, CONTAINING NO EMBEDDED REBAR OR WELDED WIRE MESH REINFORCEMENTS. GLASS FIBER REINFORCED CONCRETE CAN BE REUSED AS DESCRIBED IN THIS SECTION.

RELATIVE TO OTHER FORMS OF CONCRETE, UNREINFORCED PAVING OFFERS THE WIDEST RANGE OF REUSE POSSIBILITIES TO ACHIEVE MANY DESIGN FUNCTIONS

## ON-SITE (RE)USES

### DESIGN FUNCTION:

#### CIRCULATION



#### REUSED IN-PLACE

##### PROCESSING REQUIRED

May require milling and minor repairs to restore even surface. Not appropriate for paving with major cracking/damage

##### TESTING & PERFORMANCE REQUIREMENTS

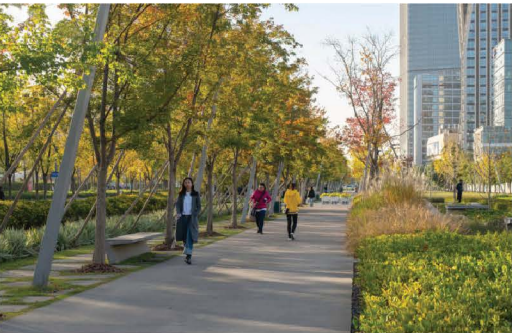
If project site is within a public right-of-way, consult local and/or department of transportation specifications for required compressive strength and allowable repair methods. Consulting a structural engineer may also be necessary.

At a minimum for ADA accessibility, surface must be smooth and slip-resistant. Vertical changes in paving level should not exceed .5" with a bevel or .25" without a bevel, and horizontal gaps should not exceed .5"

##### CARBON SAVINGS POTENTIAL

**6 kgCO<sub>2</sub>e  
per square foot**

Compared to new, 5" thick  
CIP concrete paving, concrete  
sourced within 10 miles



XUXUI RUNWAY PARK, SASAKI ASSOCIATES, 2020

IMAGE CREDIT: SASAKI

Former airport  
runway paving  
repurposed as  
paths



#### PAVERS (PEDESTRIAN USE)

##### PROCESSING REQUIRED

Cutting or breaking, sorting, setting base preparation, manual placement

##### TESTING & PERFORMANCE REQUIREMENTS

Coring or cutting paving samples to assess thickness, slip-resistance, and material consistency before designing

At a minimum for accessibility, vertical changes in paving level should not exceed .5" with a bevel or .25" without a bevel, and horizontal gaps should not exceed .5"

Pavers set with mortar will remain accessible with less maintenance over time, but be harder to reuse in the future.

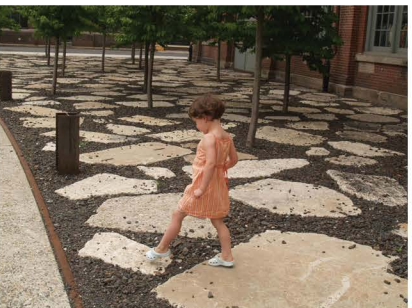
##### CARBON SAVINGS POTENTIAL

**15 kgCO<sub>2</sub>e  
per square foot**

Compared to new, 60mm  
precast concrete unit pavers  
sourced within 500 miles

**5 kgCO<sub>2</sub>e  
per square foot**

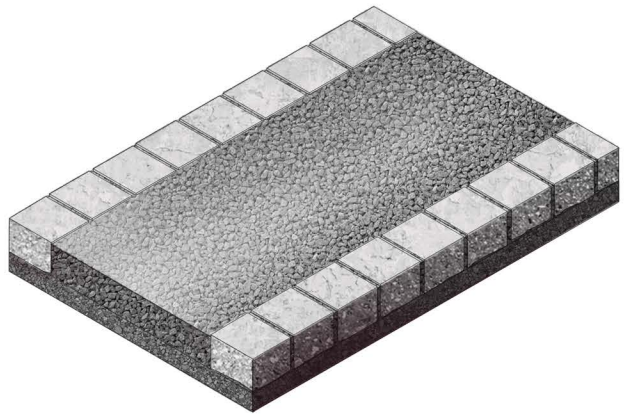
Compared to new, 60mm  
precast concrete unit pavers  
sourced within 100 miles



URBAN OUTFITTERS HEADQUARTERS,  
D.I.R.T. STUDIO, 2011

IMAGE CREDIT: D.I.R.T. STUDIO

Urbanite "flagstone"  
pavers set in aggregate  
create a pervious  
pedestrian surface



#### PATH EDGING

##### PROCESSING REQUIRED

Cutting or breaking, sorting for desired sizes, manual placing

##### TESTING & PERFORMANCE REQUIREMENTS

Coring or cutting paving samples to assess thickness and durability before designing may be helpful.

For use as a mow curb, assume 6" minimum width, a stable, well-compacted base, and the ability to set pavers at an even height are needed.

##### CARBON SAVINGS POTENTIAL

**3 kgCO<sub>2</sub>e  
per linear foot**

Compared to new CIP concrete  
mow curb (4x6in.), concrete  
sourced within 10 miles



THE FOUNDATION WORKS, ACTON, CA

IMAGE CREDIT: TOM PELLETER





STEPS/STAIRS

PROCESSING REQUIRED

Cutting or breaking, careful removal

TESTING & PERFORMANCE REQUIREMENTS

If intended to meet ADA accessibility requirements, stairs must be uniform, with a consistent riser height between 4" and 7," and a consistent tread depth, 11" minimum. Unless sawcut and carefully installed for step uniformity, salvaged concrete steps or stairs are more appropriate in situations where another, accessible circulation option is also available.

CARBON SAVINGS POTENTIAL

190 kgCO<sub>2</sub>e  
per 5ft-wide riser, with 6in riser  
height and 14in tread depth

Compared to new CIP  
concrete stairs



PALMISANO PARK (STEARNS QUARRY), SITE  
DESIGN GROUP, LTD. / D.I.R.T. STUDIO, 2010

Salvaged  
concrete slabs  
from city sidewalk  
and foundation  
demolition create  
broad steps and  
waterfall features  
elsewhere on-site

IMAGE CREDIT: ERIC ALLIX ROGERS



CRUSHED AGGREGATE SURFACING\*

PROCESSING REQUIRED

On-site crushing using portable crusher, spreading, compacting

TESTING & PERFORMANCE REQUIREMENTS

If project site is within public right of way, confirm recycled concrete aggregate is an accepted surface and that sufficient compaction can be achieved to meet local and/or department of transportation specifications (for vehicular use).

CARBON SAVINGS POTENTIAL

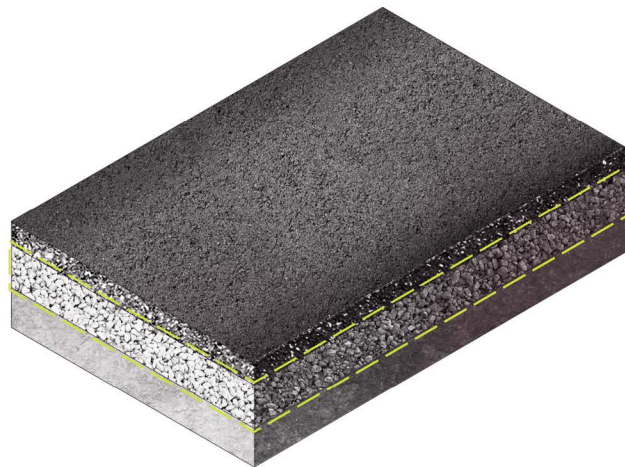
4 kgCO<sub>2</sub>e  
per square foot, 6in deep

Compared to new crushed  
gravel aggregate, sourced  
within 100 miles



Crushed concrete  
aggregate

IMAGE: BRAY TOPSOIL AND GRAVEL



CRUSHED AGGREGATE BASE COURSE\*

PROCESSING REQUIRED

On-site crushing using portable crusher, spreading, compacting

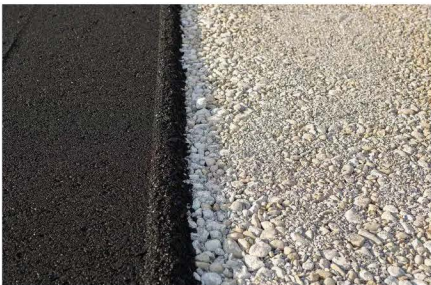
TESTING & PERFORMANCE REQUIREMENTS

If project site is within public right-of-way, confirm recycled concrete aggregate is an accepted subbase material and that sufficient compaction can be achieved to meet local and/or department of transportation specifications (for vehicular use).

CARBON SAVINGS POTENTIAL

4 kgCO<sub>2</sub>e  
per square foot, 6in deep

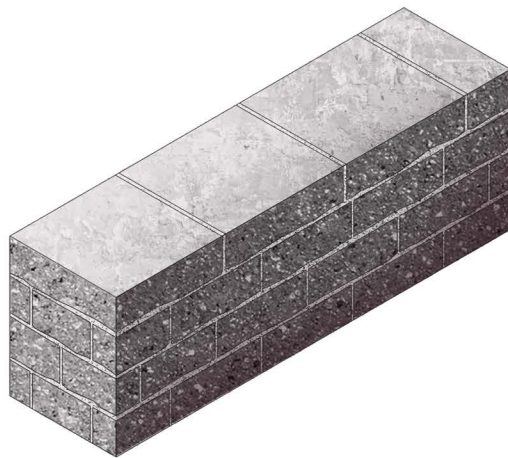
Compared to new  
compacted crushed  
aggregate base, sourced  
within 100 miles



Crushed concrete  
aggregate as a base  
course for asphalt  
paving

IMAGE: MACHINERY PARTNER

SEATING



MASONRY SEAT WALL

PROCESSING REQUIRED

Cutting or breaking paving into masonry units, typical dry-stack or mortar masonry building techniques

TESTING & PERFORMANCE REQUIREMENTS

Coring or cutting paving samples to assess thickness and durability before designing

May need to consult a structural engineer, especially if wall also provides soil retention in addition to seating

CARBON SAVINGS POTENTIAL

42 kgCO<sub>2</sub>e  
per linear foot, 15in  
wide by 24in tall

Compared to new CIP concrete wall with  
#4 vertical rebar 24 in. O.C. and four  
#4 horizontal rebar. Concrete sourced  
within 10 miles; rebar within 100 miles



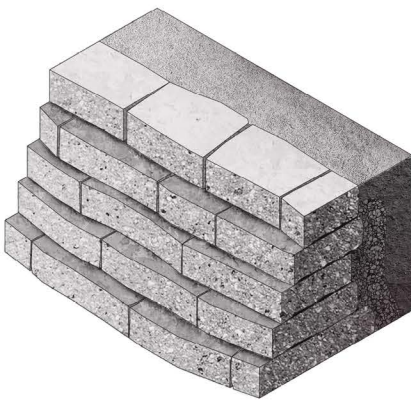
PETE V. DOMENICI U.S. COURTHOUSE LANDSCAPE  
RETROFIT, RIOS CLEMENTI HALE STUDIO, 2013

Saw-cut blocks  
of old sidewalk  
paving stacked  
and mortared  
into seat walls  
(L). Cut blocks  
staged on  
pallets during  
construction (R)

IMAGES: RIOS CLEMENTI HALE STUDIO



SLOPE/SOIL RETENTION



MASONRY RETAINING WALL

**PROCESSING REQUIRED**  
Cutting or breaking paving into masonry units, typical dry-stack or mortar masonry building techniques

**TESTING & PERFORMANCE REQUIREMENTS**  
Coring or cutting paving samples to assess thickness and durability before designing  
May need to consult a structural engineer. Recommended for any wall over 3’ and required for walls over 4’

**CARBON SAVINGS POTENTIAL**

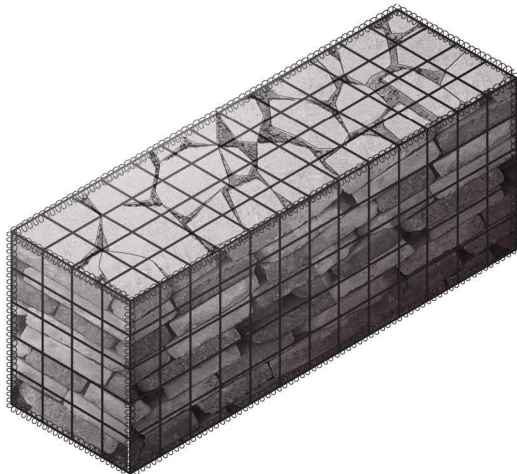
**60 kgCO<sub>2</sub>e per linear foot, 3ft tall**

Compared to new 8” wide CMU block wall, made from blocks sourced within 100 miles, footings excluded



IMAGE CREDIT: BIOHABITATS

THORNHURST SPRAGUE ROAD BANK STABILIZATION, BIOHABITATS, DATE UNKNOWN



RUBBLE-FILLED GABION

**PROCESSING REQUIRED**  
Breaking, sorting rubble for desired size range

**TESTING & PERFORMANCE REQUIREMENTS**  
May need to consult a structural engineer. Recommended for any wall over 3’ and required for walls over 4’

**CARBON SAVINGS POTENTIAL**

**60 kgCO<sub>2</sub>e per linear foot, 3ft tall**

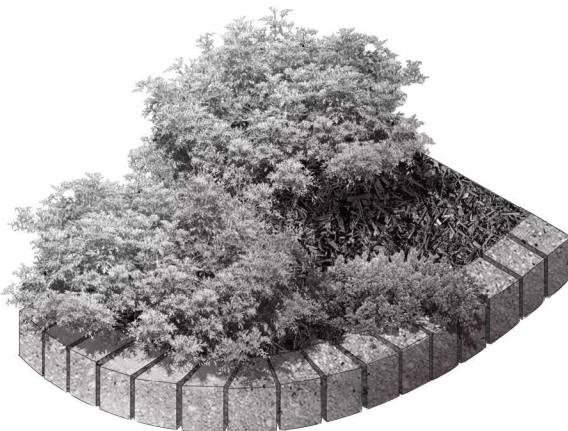
Compared to new 8” wide CMU block wall, made from blocks sourced within 100 miles, or CIP concrete wall of same dimensions, footings and reinforcements excluded



IMAGE SAHAR COSTON-HARDY

ATLANTA DAIRIES, PERKINS & WILL, 2019

HORTICULTURAL



PLANT BED EDGING

**PROCESSING REQUIRED**  
Cutting or breaking, sorting for desired sizes, manual placement

**TESTING & PERFORMANCE REQUIREMENTS**  
Coring or cutting paving samples to assess thickness and durability before designing is recommended. For use as a mow curb, assume 6” minimum width, a stable, well-compacted base, and the ability to set pavers at an even height are needed.

**CARBON SAVINGS POTENTIAL**

**2 kgCO<sub>2</sub>e per linear foot**

Compared to new CIP concrete mow curb (4x6in.), sourced within 10 miles



IMAGE CREDIT: YANN MONEL

STILL ALIVE!, WAGON LANDSCAPING, 2023



MULCH (LARGE RUBBLE)

**PROCESSING REQUIRED**  
Breaking into rubble , sorting, manually placing

**TESTING & PERFORMANCE REQUIREMENTS**  
None required

**CARBON SAVINGS POTENTIAL**

**2 kgCO<sub>2</sub>e per square foot, 2.5in depth**

Compared to gravel mulch, sourced within 100 miles

**7.5 kgCO<sub>2</sub>e per square foot**

Compared to new, 60mm precast concrete pavers sourced within 500 miles, with 50% paver coverage



IMAGE CREDIT: CHESAPEAKE STORMWATER NETWORK

WASHINGTON AVENUE GREEN “RUBBLE MEADOW,” BIOHABITATS / STACY LEVY, 2010



IMAGE CREDIT: ANDREW LOUW, CSI 2016

DUTCH KILLS GREEN (“NO-GO” BARRIERS), WRT / MARGIE RUDDICK LANDSCAPE, 2011





MULCH (CRUSHED)\*

PROCESSING REQUIRED  
On-site crushing using portable crusher

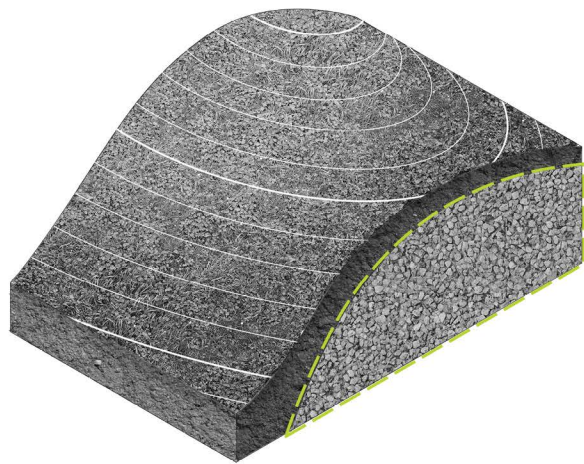
TESTING & PERFORMANCE REQUIREMENTS  
Crushed concrete mulch may not be appropriate for all plant species or in all landscape situations.

CARBON SAVINGS POTENTIAL  
**2 kgCO<sub>2</sub>e**  
per square foot, 2.5in depth  
Compared to gravel mulch,  
sourced within 100 miles



URBAN OUTFITTERS HEADQUARTERS,  
D.I.R.T. STUDIO, 2011  
Crushed concrete, asphalt  
and brick rubble salvaged  
from a former industrial site  
is blended into a coarse  
mulch used around trees

LANDFORM



CRUSHED FILL\*

PROCESSING REQUIRED  
On-site crushing using portable crusher with separator,  
screening/sorting for needed aggregate size range

TESTING & PERFORMANCE REQUIREMENTS  
May need to consult a structural and/or geotechnical engineer

CARBON SAVINGS POTENTIAL  
**11 kgCO<sub>2</sub>e**  
per cubic foot  
Compared to new, lightweight  
structural fill (geofoam) sourced  
within 500 miles



SALVATION ARMY KROC CORPS COMMUNITY CENTER,  
ANDROPOGON ASSOCIATES, 2010  
Nearly all  
existing  
paving  
was reused  
on-site as  
crushed  
aggregate  
base and fill



## EXISTING MATERIAL



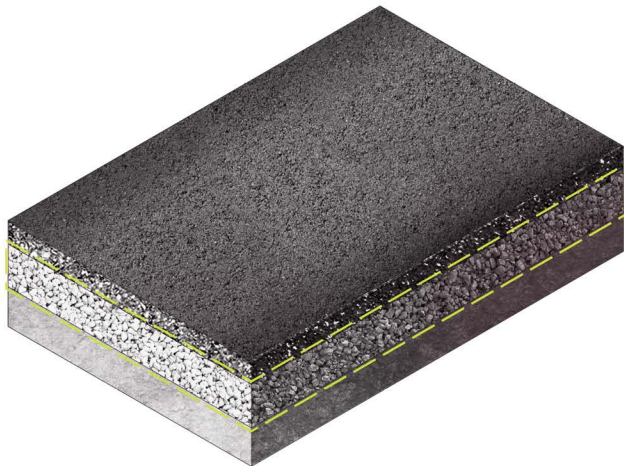
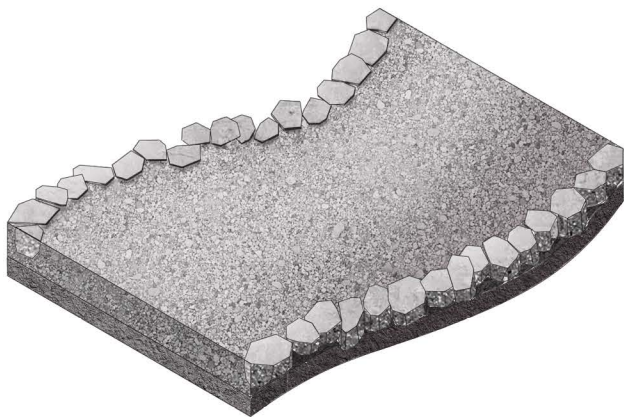
### Paving/flatwork (reinforced)

CAST-IN-PLACE FLATWORK PAVING SUCH AS VEHICULAR ROADS, SIDEWALKS, MULTIUSE PATHS, PLAZAS, AND PADS, REINFORCED WITH REBAR OR WELDED WIRE MESH. CONCRETE REINFORCED WITH GLASS FIBER IS INCLUDED IN THE PREVIOUS SECTION, PAVING/FLATWORK (UNREINFORCED).

LARGE REINFORCED SLABS ARE DIFFICULT TO SAW-CUT OR SALVAGE WITHOUT BREAKING, AND BEST REUSED DOWNCYCLED INTO RUBBLE OR CRUSHED AGGREGATE FORMS.

## ON-SITE (RE)USES

### CIRCULATION



### REUSED IN-PLACE

#### PROCESSING REQUIRED

May require milling and minor repairs to restore even surface. Not appropriate for paving with major cracking/damage

#### TESTING & PERFORMANCE REQUIREMENTS

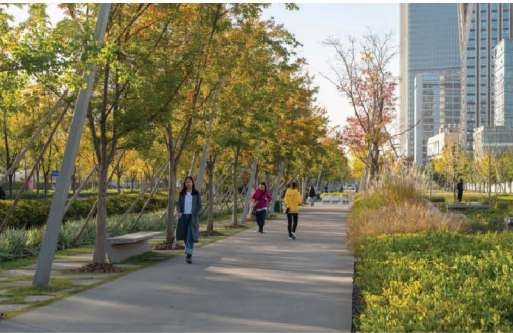
If project site is within a public right-of-way, consult local and/or department of transportation specifications for required compressive strength and allowable repair methods. Consulting a structural engineer may also be necessary.

At a minimum for accessibility, surface must be smooth and slip-resistant. Vertical changes in paving level should not exceed .5" with a bevel or .25" without a bevel, and horizontal gaps should not exceed .5"

#### CARBON SAVINGS POTENTIAL

**9 kgCO<sub>2</sub>e**  
**per square foot**

Compared to new, 6" CIP paving reinforced with #4 rebar 12 in. O.C.E.W. Concrete transported within 10 miles of site; rebar sourced within 100 miles



XUXUI RUNWAY PARK, SASAKI ASSOCIATES, 2020

Former airport runway paving repurposed as paths

IMAGE CREDIT: SASAKI

### PATH EDGING

#### PROCESSING REQUIRED

Cutting or breaking, sorting from reinforcements and for desired sizes, manual placing. Saw cutting is difficult and costly

#### TESTING & PERFORMANCE REQUIREMENTS

Coring or cutting paving samples to assess thickness and durability before designing may be helpful.

Not recommended for use as a mow curb.

#### CARBON SAVINGS POTENTIAL

**3 kgCO<sub>2</sub>e**  
**per linear foot**

Compared to new CIP concrete mow curb (4x6in.), sourced within 10 miles



THE FOUNDATION WORKS, ACTON, CA

IMAGE CREDIT: TOM PELLETIER

### CRUSHED AGGREGATE SURFACING\*

#### PROCESSING REQUIRED

On-site crushing using portable crusher with magnetic separator, spreading, compacting

#### TESTING & PERFORMANCE REQUIREMENTS

If project site is within public right of way, confirm recycled concrete aggregate is an accepted surface and that sufficient compaction can be achieved to meet local and/or department of transportation specifications (for vehicular use).

#### CARBON SAVINGS POTENTIAL

**3 kgCO<sub>2</sub>e**  
**per square foot, 6in deep**

Compared to new crushed gravel aggregate, sourced within 100 miles



Crushed concrete aggregate

IMAGE: BRAY TOPSOIL AND GRAVEL

### CRUSHED AGGREGATE BASE COURSE\*

#### PROCESSING REQUIRED

On-site crushing using portable crusher with magnetic separator, spreading, compacting

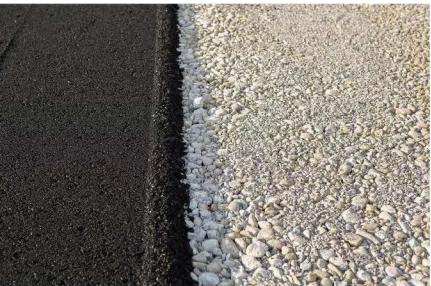
#### TESTING & PERFORMANCE REQUIREMENTS

If project site is within public right of way, confirm recycled concrete aggregate is an accepted subbase material and that sufficient compaction can be achieved to meet local and/or department of transportation specifications (for vehicular use).

#### CARBON SAVINGS POTENTIAL

**3 kgCO<sub>2</sub>e**  
**per square foot, 6in deep**

Compared to new compacted crushed aggregate base, sourced within 100 miles

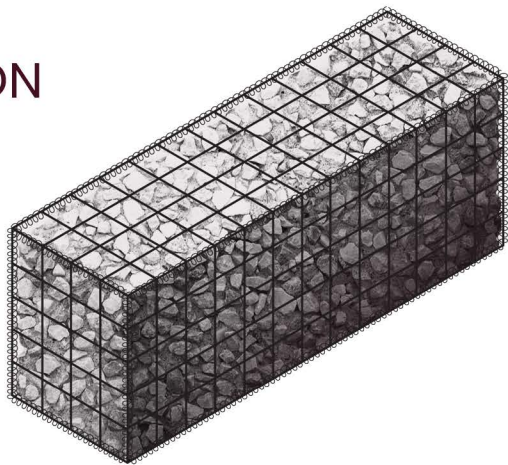


Crushed concrete aggregate as a base course for asphalt paving

IMAGE: MACHINERY PARTNER



SLOPE/SOIL RETENTION



RUBBLE-FILLED GABION

PROCESSING REQUIRED

Breaking, sorting from reinforcements, sorting rubble for desired size range

TESTING & PERFORMANCE REQUIREMENTS

May need to consult a structural engineer. Recommended for any wall over 3’ and required for walls over 4’

CARBON SAVINGS POTENTIAL

**60 kgCO<sub>2</sub>e**  
per linear foot, 3ft tall

Compared to new 8” wide CMU block wall, made from blocks sourced within 100 miles, or CIP concrete wall of same dimensions, footings and reinforcements excluded



IMAGE CREDIT: SAHAR COSTON-HARDY

Former loading yard pavement is salvaged in rubble-filled gabions used at grade transitions and to define space throughout the site

ATLANTA DAIRIES, PERKINS & WILL, 2019

HORTICULTURAL



PLANT BED EDGING

PROCESSING REQUIRED

Cutting or breaking, sorting for desired sizes, manual placement

TESTING & PERFORMANCE REQUIREMENTS

Coring or cutting paving samples to assess thickness and durability before designing is recommended. For use as a mow curb, assume 6” minimum width, a stable, well-compacted base, and the ability to set pavers at an even height are needed.

CARBON SAVINGS POTENTIAL

**2 kgCO<sub>2</sub>e**  
per linear foot

Compared to new CIP concrete mow curb (4x6in.), sourced within 10 miles

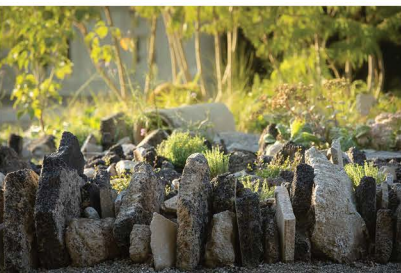


IMAGE CREDIT: YANN MONEL

Thin slabs set on edge define the border of a planted area

STILL ALIVE!, WAGON LANDSCAPING, 2023



MULCH (LARGE RUBBLE)

PROCESSING REQUIRED

Breaking into rubble , sorting, manually placing

TESTING & PERFORMANCE REQUIREMENTS

None required

CARBON SAVINGS POTENTIAL

**2 kgCO<sub>2</sub>e**  
per square foot, 2.5in depth

Compared to gravel mulch, sourced within 100 miles

**7.5 kgCO<sub>2</sub>e**  
per square foot

Compared to new, 60mm precast concrete pavers sourced within 500 miles, with 50% paver coverage



IMAGE CREDIT: CHESAPEAKE STORMWATER NETWORK

Broken rubble doubles as a mulch and pavers through meadow plantings

WASHINGTON AVENUE GREEN “RUBBLE MEADOW,” BIOHABITATS / STACY LEVY 2010



MULCH (CRUSHED)\*

PROCESSING REQUIRED

On-site crushing and sorting from reinforcements using portable crusher with separator

TESTING & PERFORMANCE REQUIREMENTS

Concrete mulch may not be appropriate for all plant species or in all landscape situations.

CARBON SAVINGS POTENTIAL

**1 kgCO<sub>2</sub>e**  
per square foot, 2.5in depth

Compared to gravel mulch, sourced within 100 miles of the site



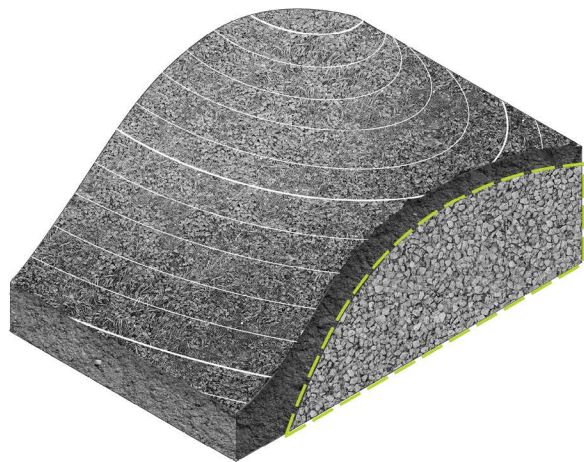
IMAGE CREDIT: D.I.R.T. STUDIO

Crushed concrete, asphalt and brick rubble salvaged from a former industrial site is blended into a coarse mulch used around trees

URBAN OUTFITTERS HEADQUARTERS, D.I.R.T. STUDIO, 2011



LANDFORM



CRUSHED FILL\*

PROCESSING REQUIRED

On-site crushing using portable crusher with separator, screening/sorting for needed aggregate size range

TESTING & PERFORMANCE REQUIREMENTS

May need to consult a structural and/or geotechnical engineer

CARBON SAVINGS POTENTIAL

11 kgCO<sub>2</sub>e  
per cubic foot

Compared to new, lightweight structural fill (geofoam) sourced within 500 miles



IMAGE CREDIT: ANDROPOGON ASSOCIATES

Nearly all existing paving was reused on-site as crushed aggregate base and fill

SALVATION ARMY KROC CORPS COMMUNITY CENTER, ANDROPOGON ASSOCIATES, 2010



## EXISTING MATERIAL



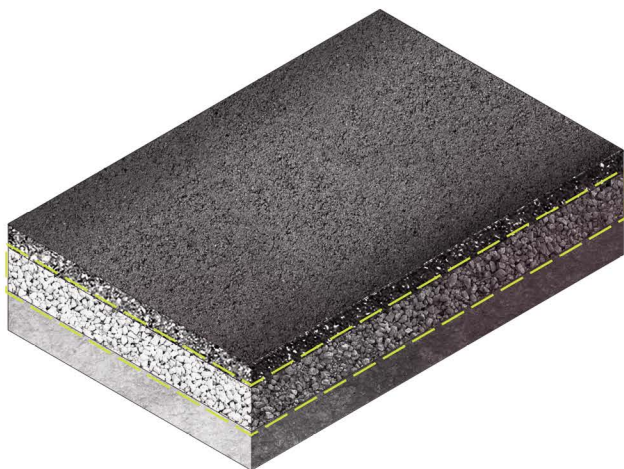
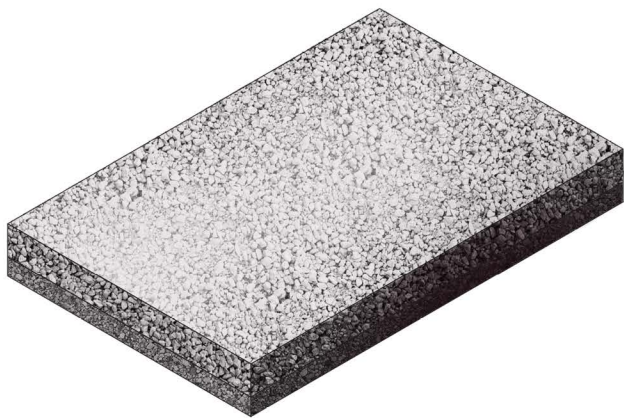
### Precast Furnishings and Site Elements

PRECAST, FREESTANDING CONCRETE FURNISHINGS AND ELEMENTS SUCH AS PLANTERS, SEATING, BOLLARDS, BIKE RACKS, WHEEL STOPS AND OTHERS.

IF TEMPORARY ON-SITE STORAGE DURING CONSTRUCTION IS POSSIBLE, SALVAGE AND REUSE OF ELEMENTS AS-IS OFFERS THE GREATEST POTENTIAL CARBON SAVINGS.

## ON-SITE (RE)USES

### CIRCULATION



### CRUSHED AGGREGATE SURFACING\*

#### PROCESSING REQUIRED

On-site crushing using portable crusher, spreading, compacting

#### TESTING & PERFORMANCE REQUIREMENTS

Recommended for precast furnishings and elements that are too damaged to be reused as-is, repaired, or upcycled.  
If project site is within public right of way, confirm recycled concrete aggregate is an accepted surface and that sufficient compaction can be achieved to meet local and/or department of transportation specifications (for vehicular use).

#### CARBON SAVINGS POTENTIAL

**4 kgCO<sub>2</sub>e**  
**per square foot, 6in. deep**

Compared to new crushed gravel aggregate, sourced within 100 miles



Crushed concrete aggregate

### CRUSHED AGGREGATE BASE COURSE\*

#### PROCESSING REQUIRED

On-site crushing using on-site crusher, spreading, compacting

#### TESTING & PERFORMANCE REQUIREMENTS

Recommended for precast furnishings and elements that are too damaged to be reused as-is or upcycled.  
If project site is within public right of way, confirm recycled concrete aggregate is an accepted subbase material and that sufficient compaction can be achieved to meet local and/or department of transportation specifications (for vehicular use).

#### CARBON SAVINGS POTENTIAL

**4 kgCO<sub>2</sub>e**  
**per square foot, 6in deep**

Compared to new compacted crushed aggregate base, sourced within 100 miles



Crushed concrete aggregate as a base course for asphalt paving

### SEATING



### REUSE AS-IS (SEATING)

#### PROCESSING REQUIRED

Careful deinstallation and storage during construction. Grinding and patching may be needed to repair minor damage

#### TESTING & PERFORMANCE REQUIREMENTS

Recommended only for precast seating elements in good condition (no major structural cracking or significant damage)

#### CARBON SAVINGS POTENTIAL

Varies with product. Carbon savings may be significantly reduced by transportation emissions if salvaged elements must be stored off-site during construction



IMAGE BY AUTHOR

### UPCYCLE / ALTER

#### PROCESSING REQUIRED

Careful deinstallation and storage during construction. Grinding and patching may be needed to repair minor damage. Cutting and/or milling may be needed for more significant alterations. Upcycling existing precast seating through alterations such as adding wooden benchtops may require off-site manufacturing and hardware

#### TESTING & PERFORMANCE REQUIREMENTS

Recommended only for precast seating elements in good condition (no major structural cracking or significant damage)

#### CARBON SAVINGS POTENTIAL

Varies with product and alterations. Carbon savings may be significantly reduced by transportation emissions if salvaged elements are transported off-site for processing and/or temporary storage. Manufacturing of new parts will also be a source of emissions.



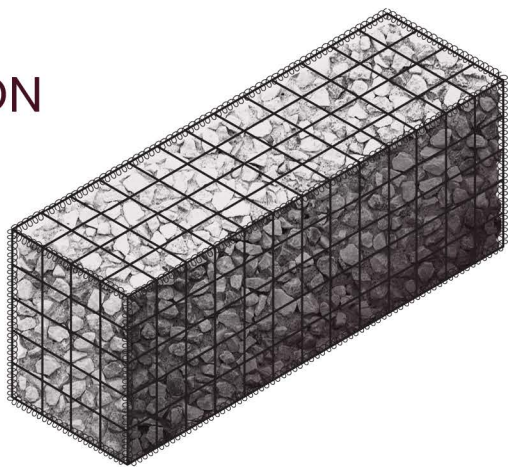
Salvaged concrete used for design elements

Wooden backrests are added to thick slabs of salvaged concrete paving

ELLINIKON PARK, SASAKI ASSOCIATES, IN PROGRESS



SLOPE/SOIL RETENTION



RUBBLE-FILLED GABION

PROCESSING REQUIRED

Breaking, sorting rubble for desired size range

TESTING & PERFORMANCE REQUIREMENTS

May need to consult a structural engineer. Recommended for any wall over 3’ and required for walls over 4’

CARBON SAVINGS POTENTIAL

60 kgCO<sub>2</sub>e  
per linear foot, 3ft tall

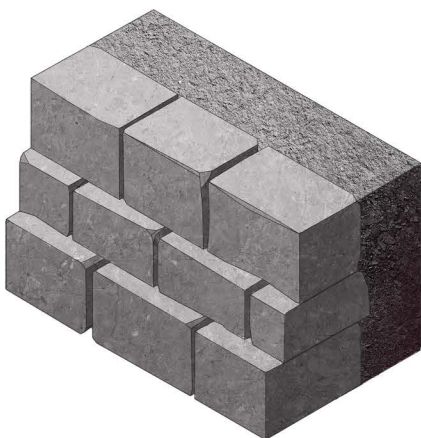
Compared to new 8” wide CMU block wall, made from blocks sourced within 100 miles, or CIP concrete wall of same dimensions, footings and reinforcements excluded



IMAGE: SAHAR COSTON-HARDY

Former loading yard pavement is salvaged in rubble-filled gabions used at grade transitions and to define space throughout the site

ATLANTA DAIRIES, PERKINS & WILL, 2019



RETAINING WALL

PROCESSING REQUIRED

Cutting precast elements to size as needed, varied masonry techniques

TESTING & PERFORMANCE REQUIREMENTS

May need to consult a structural engineer. Recommended for any wall over 3’ and required for walls over 4’

Most appropriate for rectangular and blocky precast elements

CARBON SAVINGS POTENTIAL

61 kgCO<sub>2</sub>e  
per linear foot, 3ft tall

Compared to new 8” wide CMU block wall, made from blocks sourced within 100 miles, footings excluded



IMAGE CREDIT: DE MOLFETTA STRODE

Irregularly sized precast architectural blocks help hold back soil on a planted slope and form a stacked bouldering wall

PICO PLAYGROUND, DE MOLFETTA STRODE, 2022

HORTICULTURAL



REUSE AS-IS (PLANTERS)

PROCESSING REQUIRED

Careful deinstallation and storage during construction. Grinding and patching may be needed to repair minor damage

TESTING & PERFORMANCE REQUIREMENTS

Recommended only for precast planters in good condition (no major structural cracking or significant damage)

CARBON SAVINGS POTENTIAL

Varies by type and size of planter



IMAGE BY AUTHOR



MULCH (CRUSHED)\*

PROCESSING REQUIRED

On-site crushing using portable crusher

TESTING & PERFORMANCE REQUIREMENTS

Concrete mulch may not be appropriate for all plant species or in all landscape situations.

CARBON SAVINGS POTENTIAL

2 kgCO<sub>2</sub>e  
per square foot, 2.5in depth

Compared to gravel mulch, sourced within 100 miles

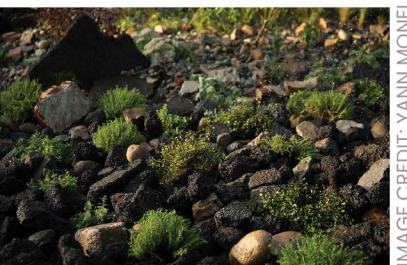


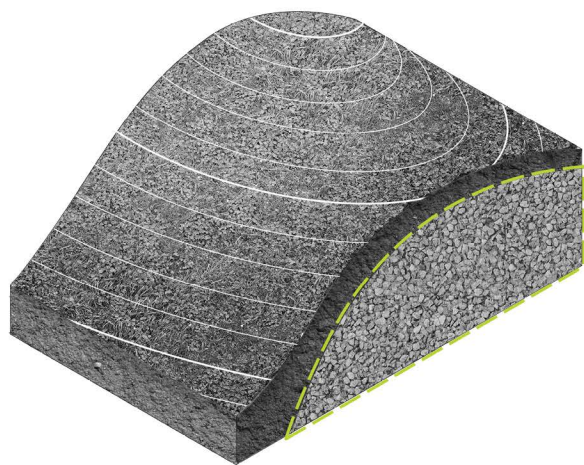
IMAGE CREDIT: YANN MOVIEL

Blended demolition debris forms a rock garden mulch

STILL ALIVE!, WAGON LANDSCAPING, 2023



LANDFORM



CRUSHED FILL\*

PROCESSING REQUIRED

On-site crushing using portable crusher with separator, screening/sorting for needed aggregate size range

TESTING & PERFORMANCE REQUIREMENTS

May need to consult a structural and/or geotechnical engineer

CARBON SAVINGS POTENTIAL

11 kgCO<sub>2</sub>e  
per cubic foot

Compared to new, lightweight  
structural fill (geofoam) sourced  
within 500 miles



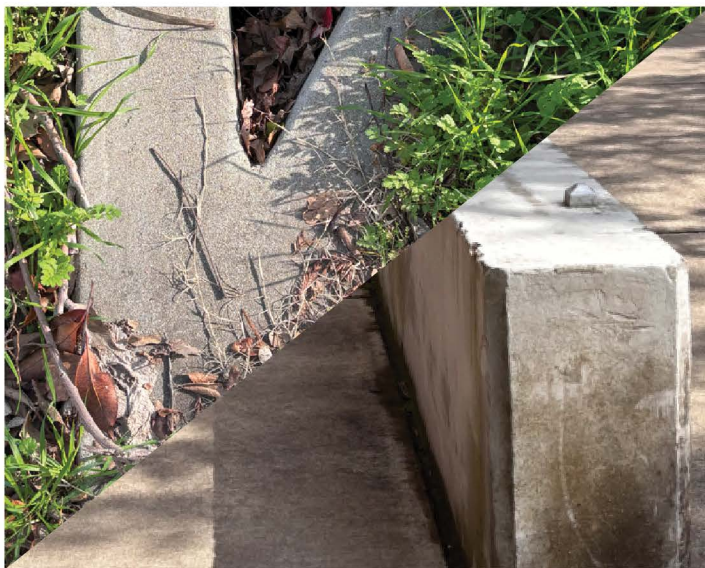
IMAGE CREDIT: ANDROPOGON ASSOCIATES

SALVATION ARMY KROC CORPS COMMUNITY CENTER, ANDROPOGON ASSOCIATES, 2010

Nearly all  
existing  
paving  
was reused  
on-site as  
crushed  
aggregate  
base and fill



## EXISTING MATERIAL



### Cast-in-Place Furnishings and Site Elements

CAST-IN-PLACE CONCRETE SITE ELEMENTS SUCH AS SEAT WALLS, RETAINING WALLS, STAIRS AND STEPS, CURBS, FOOTINGS, AND OTHERS, WITH OR WITHOUT EMBEDDED REINFORCEMENTS.

CAST-IN-PLACE CONCRETE ELEMENTS CAN BE DIFFICULT TO SALVAGE WITHOUT BREAKING OR SIGNIFICANT DAMAGE. IF NOT REUSED IN-PLACE AS-IS, THE MOST VIABLE REUSE OPTION MAY BE DOWNCYCLING INTO RUBBLE OR CRUSHED AGGREGATE FORMS.

## ON-SITE (RE)USES

### CIRCULATION



### CRUSHED AGGREGATE SURFACING\*

#### PROCESSING REQUIRED

On-site crushing using portable crusher with magnetic separator for reinforced elements, spreading, compacting

#### TESTING & PERFORMANCE REQUIREMENTS

If project site is within public right of way, confirm recycled concrete aggregate is an accepted surface and that sufficient compaction can be achieved to meet local and/or department of transportation specifications (for vehicular use).

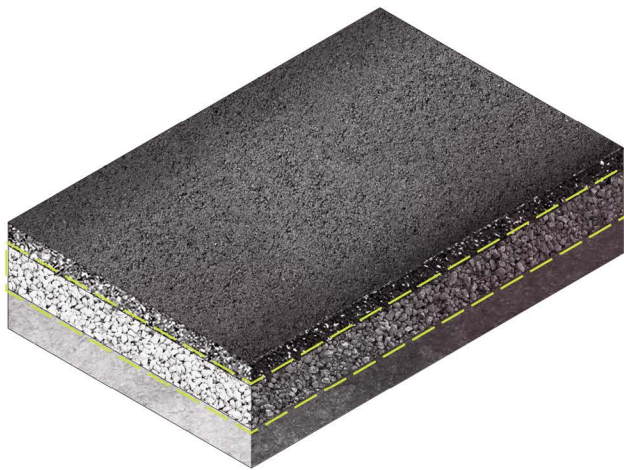
#### CARBON SAVINGS POTENTIAL

**3 kgCO<sub>2</sub>e**  
per square foot, 6in deep

Compared to new crushed gravel aggregate, sourced within 100 miles



Crushed concrete aggregate



### CRUSHED AGGREGATE BASE COURSE\*

#### PROCESSING REQUIRED

On-site crushing using portable crusher with magnetic separator for reinforced elements, spreading, compacting

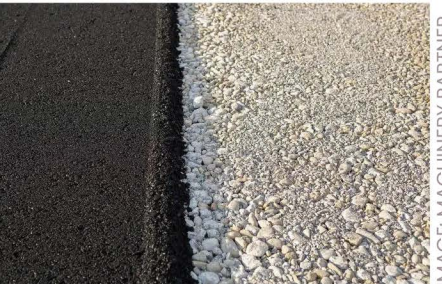
#### TESTING & PERFORMANCE REQUIREMENTS

If project site is within public right of way, confirm recycled concrete aggregate is an accepted subbase material and that sufficient compaction can be achieved to meet local and/or department of transportation specifications (for vehicular use).

#### CARBON SAVINGS POTENTIAL

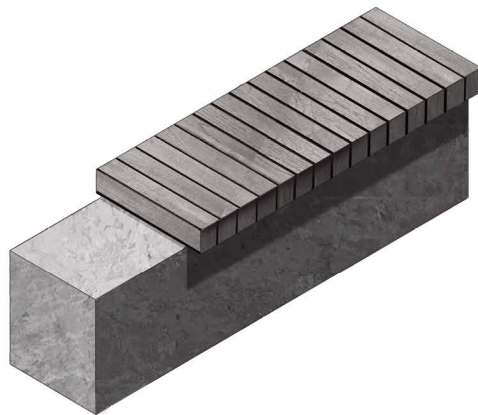
**3 kgCO<sub>2</sub>e**  
per square foot, 6in deep

Compared to new compacted crushed aggregate base, sourced within 100 miles



Crushed concrete aggregate as a base course for asphalt paving

### SEATING



### RETROFIT IN-PLACE

#### PROCESSING REQUIRED

Resurfacing or grinding sharp edges, minor patching. Upcycling existing precast seating through alterations such as adding wooden benchtops may require off-site manufacturing and hardware

#### TESTING & PERFORMANCE REQUIREMENTS

Only appropriate for existing cast-in-place seating without major structural damage.

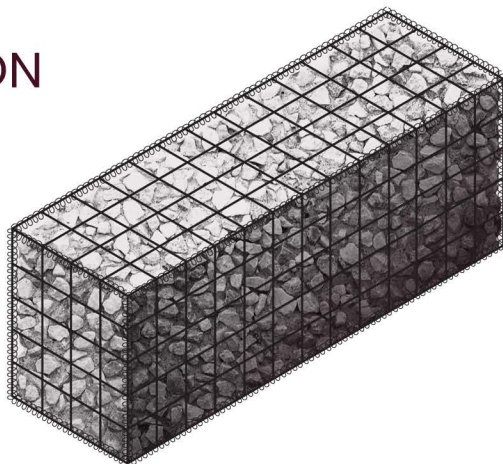
#### CARBON SAVINGS POTENTIAL

Varies with specific material additions, alterations and repairs. Manufacture and transport of any new parts will be a source of emissions.



New wooden benchtops installed on concrete seat walls

### SLOPE/SOIL RETENTION



### RUBBLE-FILLED GABION

#### PROCESSING REQUIRED

Demolition and separating of concrete from reinforcements, sorting broken rubble for desired sizes.

#### TESTING & PERFORMANCE REQUIREMENTS

May need to consult a structural engineer. Recommended for any wall over 3' and required for walls over 4'

#### CARBON SAVINGS POTENTIAL

**60 kgCO<sub>2</sub>e**  
per linear foot, 3ft tall

Compared to new 8" wide CMU block wall, made from blocks sourced within 100 miles, or CIP concrete wall of same dimensions, footings and reinforcements excluded



Former loading yard pavement is salvaged in rubble-filled gabions used at grade transitions and to define space throughout the site

ATLANTA DAIRIES, PERKINS & WILL, 2019



## EXISTING MATERIAL



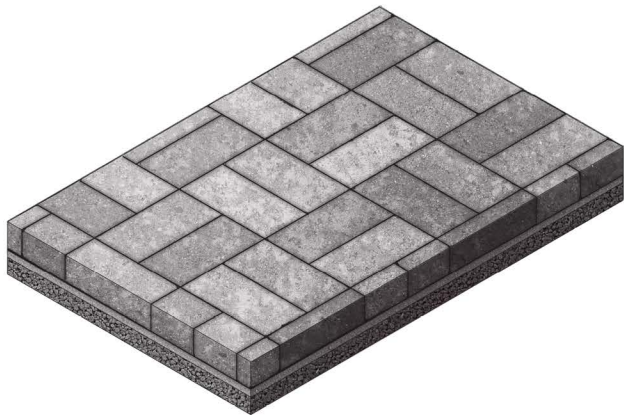
### Precast Unit Pavers (dry-laid)

PRECAST CONCRETE UNIT PAVERS SUCH AS INTERLOCKING, PERVIOUS, AND STEPPING STONE PAVERS OF ANY DIMENSION, SET IN SAND. PAVERS SET IN POLYMERIC SAND ARE INCLUDED IN THE FOLLOWING SECTION, PRECAST UNIT PAVERS (MORTARED).

DRY-LAID PRECAST CONCRETE PAVERS CAN BE REUSED MULTIPLE TIMES AS PAVING SYSTEMS.

## ON-SITE (RE)USES

### CIRCULATION



### RESET AS PAVERS

#### PROCESSING REQUIRED

Careful removal and temporary storage, base course preparation, and resetting. Resetting in sand on a compacted or consolidated aggregate base is preferred for permeability and future reuse. Some intended uses may require a reinforced concrete base.

#### TESTING & PERFORMANCE REQUIREMENTS

At a minimum for accessibility, paving surface must be smooth and slip-resistant. Vertical changes in level should not exceed .5" with a bevel or .25" without a bevel, and horizontal gaps should not exceed .5". Inspect pavers for cracks and chipping before resetting. For vehicular use, and in public right of way, confirm paver compressive strength meets local and department of transportation specs. 80mm paver thickness is typically required.

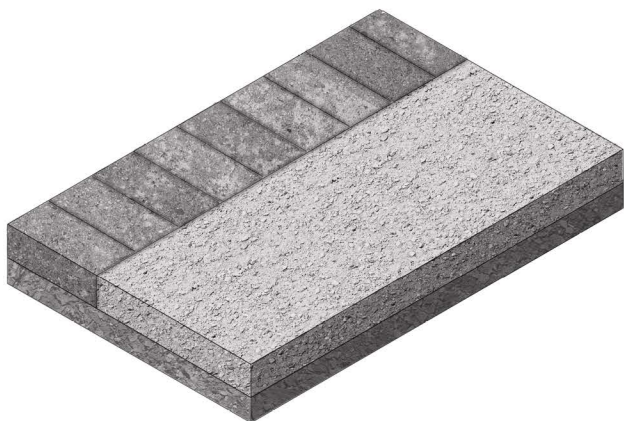
#### CARBON SAVINGS POTENTIAL

**15 kgCO<sub>2</sub>e**  
**per square foot**

Compared to new, 60mm precast concrete pavers sourced within 500 miles



IMAGE BY AUTHOR



### PATH EDGING

#### PROCESSING REQUIRED

Careful removal of pavers, breaking or cutting if desired to alter size, manual sorting and placing

#### TESTING & PERFORMANCE REQUIREMENTS

None required. Decorative path edging may be a good option for uneven or broken pavers

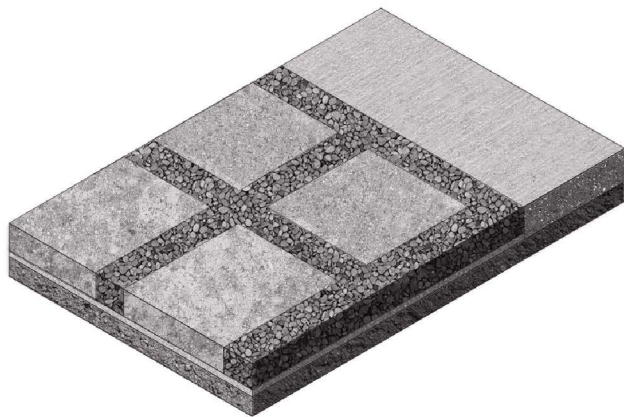
#### CARBON SAVINGS POTENTIAL

**15 kgCO<sub>2</sub>e**  
**per square foot**

Compared to new, 60mm precast concrete edging pavers sourced within 500 miles

**3 kgCO<sub>2</sub>e**  
**per linear foot**

Compared to new CIP concrete mow curb (4x6in.), sourced within 10 miles



### STEPPING STONES

#### PROCESSING REQUIRED

Careful removal of pavers, breaking or cutting if desired to alter size, manual sorting and placing

#### TESTING & PERFORMANCE REQUIREMENTS

For use as a pedestrian surface, ADA accessibility is difficult to achieve and maintain. Best used adjacent to accessible circulation as an expansion of the overall circulation area.

#### CARBON SAVINGS POTENTIAL

**15 kgCO<sub>2</sub>e**  
**per square foot**

Compared to new, 60mm precast concrete pavers sourced within 500 miles



IMAGE BY AUTHOR

Pavers reset as stepping stones expand the usable width of an adjacent path and soften the boundary between hardscape and plantings



### CRUSHED AGGREGATE SURFACING\*

#### PROCESSING REQUIRED

On-site crushing using portable crusher, spreading, compacting

#### TESTING & PERFORMANCE REQUIREMENTS

If project site is within public right of way, confirm recycled concrete aggregate is an accepted surface and that sufficient compaction can be achieved to meet local and/or department of transportation specifications (for vehicular use).

#### CARBON SAVINGS POTENTIAL

**3 kgCO<sub>2</sub>e**  
**per square foot, 6in deep**

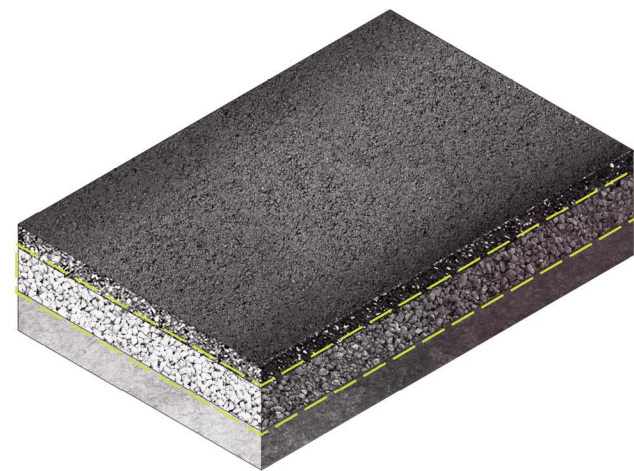
Compared to new crushed gravel aggregate, sourced within 100 miles



IMAGE: BRAY TOPSOIL AND GRAVEL



On-site Reuse of Precast Unit Pavers (dry-laid) .....



CRUSHED AGGREGATE BASE COURSE\*

PROCESSING REQUIRED

On-site crushing using portable crusher, spreading, compacting

TESTING & PERFORMANCE REQUIREMENTS

If project site is within public right of way, confirm recycled concrete aggregate is an accepted subbase material and that sufficient compaction can be achieved to meet local and/or department of transportation specifications (for vehicular use).

CARBON SAVINGS POTENTIAL

3 kgCO<sub>2</sub>e  
per square foot, 6in deep

Compared to new  
compacted crushed  
aggregate base, sourced  
within 100 miles

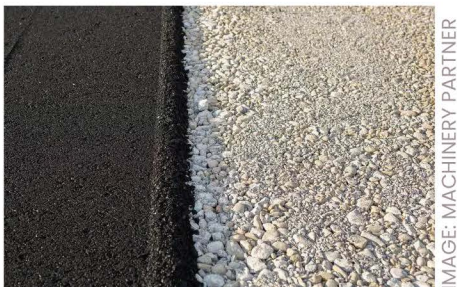
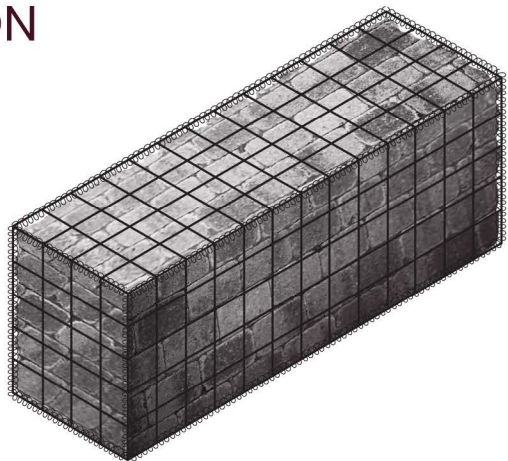


IMAGE: MACHINERY PARTNER

Crushed concrete  
aggregate as a base  
course for asphalt  
paving

SLOPE/SOIL RETENTION



GABION WALL

PROCESSING REQUIRED

Demolition of paver area to salvage concrete. Consider aesthetic opportunities of broken vs. intact pavers and pavers stacked in courses vs. randomly filled gabion baskets. Consider combining with other forms of salvage concrete, or filling the center of baskets with rubble and placing intact pavers on the exterior faces

TESTING & PERFORMANCE REQUIREMENTS

May need to consult a structural engineer. Recommended for any wall over 3' and required for walls over 4'

CARBON SAVINGS POTENTIAL

60 kgCO<sub>2</sub>e  
per linear foot, 3ft tall

Compared to new 8" wide CMU  
block wall, made from blocks  
sourced within 100 miles, or CIP  
concrete wall of same dimensions,  
footings and reinforcements  
excluded

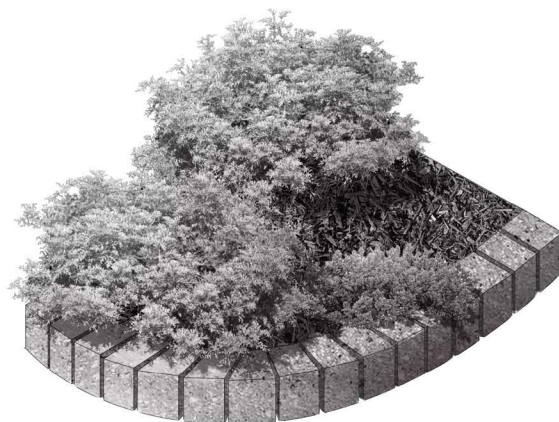


IMAGE: SAHAR COSTON-HARDY

Former loading  
yard pavement is  
salvaged in rubble-  
filled gabions used  
at grade transitions  
and to define space  
throughout the site

ATLANTA DAIRIES, PERKINS & WILL, 2019

HORTICULTURAL



PLANT BED EDGING

PROCESSING REQUIRED

Demolition of paving area and removal of pavers, intact or broken, manual sorting for desired size and placing. Consider setting larger pavers vertically on end for taller edging

TESTING & PERFORMANCE REQUIREMENTS

For use as a mow curb, assume 6" minimum width. a stable, well-compacted base, and the ability to set pavers at an even height are needed.

CARBON SAVINGS POTENTIAL

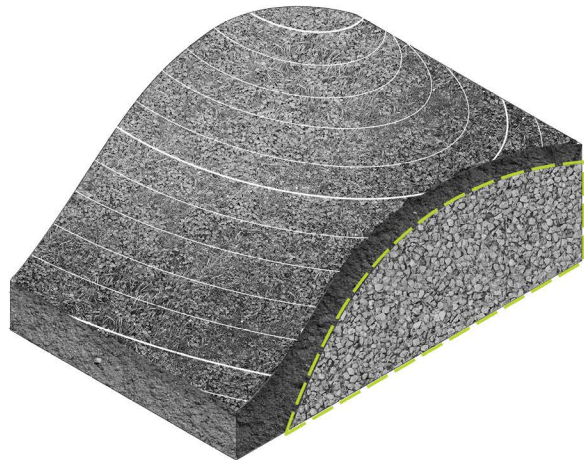
15 kgCO<sub>2</sub>e  
per square foot

Compared to new, 60mm precast  
concrete edging pavers sourced  
within 500 miles

3 kgCO<sub>2</sub>e  
per linear foot

Compared to new CIP concrete  
mow curb (4x6in.), sourced  
within 10 miles

LANDFORM



CRUSHED FILL\*

PROCESSING REQUIRED

On-site crushing using portable crusher with separator, screening/sorting for needed aggregate size range

TESTING & PERFORMANCE REQUIREMENTS

May need to consult a structural and/or geotechnical engineer

CARBON SAVINGS POTENTIAL

11 kgCO<sub>2</sub>e  
per cubic foot

Compared to new, lightweight  
structural fill (geofoam) sourced  
within 500 miles



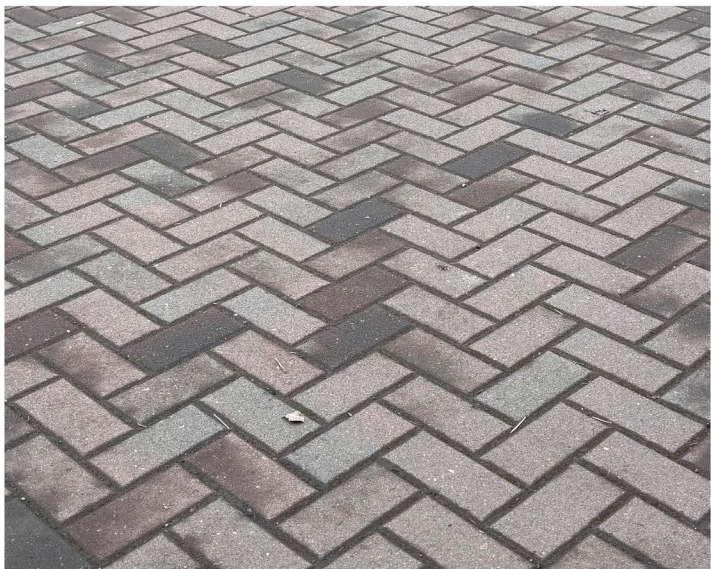
IMAGE CREDIT: ANDROPOGON ASSOCIATES

Nearly all  
existing  
paving  
was reused  
on-site as  
crushed  
aggregate  
base and fill

SALVATION ARMY KROC CORPS COMMUNITY CENTER,  
ANDROPOGON ASSOCIATES, 2010



## EXISTING MATERIAL



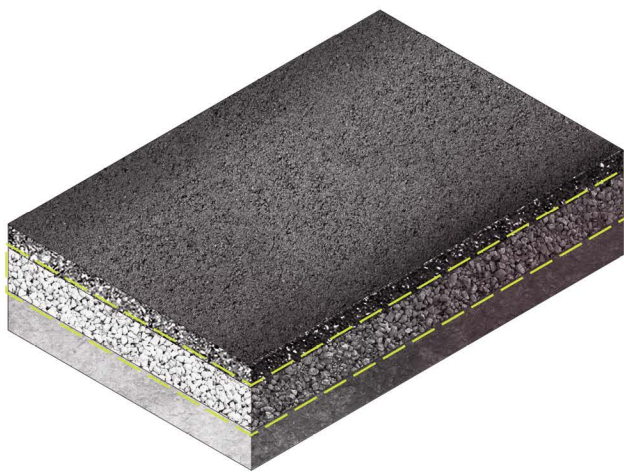
### Precast Unit Pavers (mortared)

PRECAST CONCRETE PAVERS OF ANY SHAPE AND DIMENSION SET WITH MORTAR. PAVERS SET WITH POLYMERIC SAND ARE ALSO INCLUDED IN THIS CATEGORY.

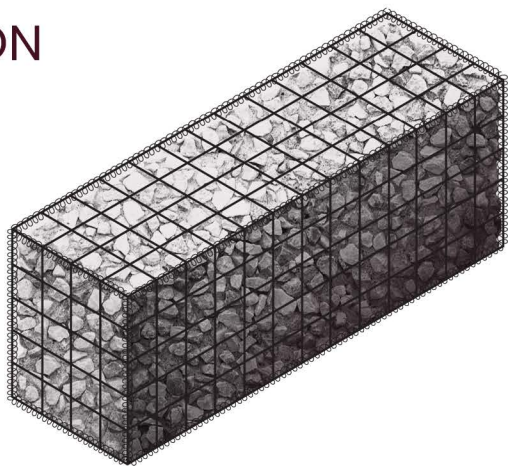
MORTARED PAVERS ARE TIME-CONSUMING AND DIFFICULT TO SALVAGE WITHOUT BREAKING. IF NOT REUSED AS-IS IN PLACE (ONLY MINOR REPAIRS NEEDED), THE MOST VIABLE REUSE OPTION MAY BE DOWNCYCLING FOR USE AS LARGE RUBBLE OR CRUSHED AGGREGATE. IF PAVERS ARE SALVAGED INTACT HOWEVER, THEY CAN BE REUSED AS DESCRIBED IN THE PREVIOUS SECTION, PRECAST UNIT PAVERS (DRY-LAID).

## ON-SITE (RE)USES

### CIRCULATION



### SLOPE/SOIL RETENTION



### HORTICULTURAL



### CRUSHED AGGREGATE SURFACING\*

#### PROCESSING REQUIRED

Demolition, on-site crushing using portable crusher, spreading, compacting

#### TESTING & PERFORMANCE REQUIREMENTS

If project site is within public right of way, confirm recycled concrete aggregate is an accepted surface and that sufficient compaction can be achieved to meet local and/or department of transportation specifications (for vehicular use).

#### CARBON SAVINGS POTENTIAL

**4 kgCO<sub>2</sub>e**  
per square foot, 6in deep

Compared to new crushed gravel aggregate, sourced within 100 miles



Crushed concrete aggregate

### CRUSHED AGGREGATE BASE COURSE\*

#### PROCESSING REQUIRED

Crushing using portable crusher with magnetic separator if reinforced concrete base is included, spreading, compacting

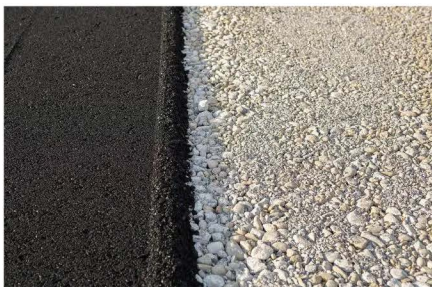
#### TESTING & PERFORMANCE REQUIREMENTS

If project site is within public right of way, confirm recycled concrete aggregate is an accepted subbase material and that sufficient compaction can be achieved to meet local and/or department of transportation specifications (for vehicular use).

#### CARBON SAVINGS POTENTIAL

**4 kgCO<sub>2</sub>e**  
per square foot, 6in deep

Compared to new compacted crushed aggregate base, sourced within 100 miles



Crushed concrete aggregate as a base course for asphalt paving

### RUBBLE-FILLED GABION

#### PROCESSING REQUIRED

Breaking up paving system, including concrete base if present, sorting rubble for desired size range

#### TESTING & PERFORMANCE REQUIREMENTS

May need to consult a structural engineer. Recommended for any wall over 3' and required for walls over 4'

#### CARBON SAVINGS POTENTIAL

**60 kgCO<sub>2</sub>e**  
per linear foot, 3ft tall

Compared to new 8" wide CMU block wall, made from blocks sourced within 100 miles, or CIP concrete wall of same dimensions, footings and reinforcements excluded



ATLANTA DAIRIES, PERKINS & WILL, 2019

### MULCH (CRUSHED)\*

#### PROCESSING REQUIRED

Crushing using portable crusher with magnetic separator if reinforced concrete base is included

#### TESTING & PERFORMANCE REQUIREMENTS

Concrete mulch may not be appropriate for all plant species or in all landscape situations.

#### CARBON SAVINGS POTENTIAL

**2 kgCO<sub>2</sub>e**  
per square foot, 2.5in depth

Compared to gravel mulch, sourced within 100 miles

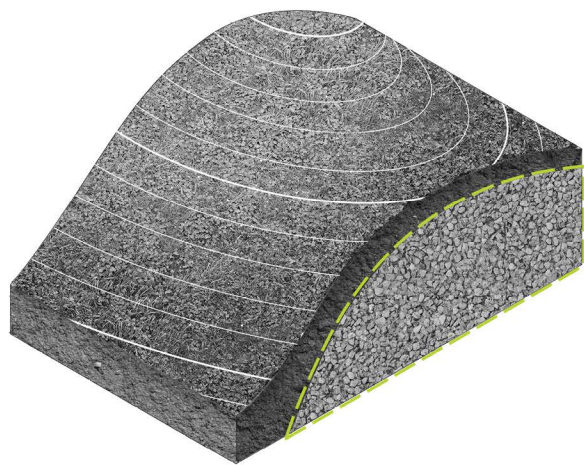


URBAN OUTFITTERS HEADQUARTERS, D.I.R.T. STUDIO, 2011

Crushed concrete, asphalt and brick rubble salvaged from a former industrial site is blended into a coarse mulch used around trees



LANDFORM



CRUSHED FILL\*

PROCESSING REQUIRED

On-site crushing using portable crusher with separator, screening/sorting for needed aggregate size range

TESTING & PERFORMANCE REQUIREMENTS

May need to consult a structural and/or geotechnical engineer

CARBON SAVINGS POTENTIAL

11 kgCO<sub>2</sub>e  
per cubic foot

Compared to new, lightweight  
structural fill (geofoam) sourced  
within 500 miles



IMAGE CREDIT: ANDROPOGON ASSOCIATES

Nearly all existing paving was reused on-site as crushed aggregate base and fill

SALVATION ARMY KROC CORPS COMMUNITY CENTER, ANDROPOGON ASSOCIATES, 2010

**\*CRUSHED CONCRETE LEACHATES AND PH**

Strong debate currently surrounds the potential environmental impacts of crushed recycled concrete aggregate (RCA). Most research to date has focused on subgrade use for highway construction using laboratory testing and models to measure leachate pH, alkalinity, and metal and other element leaching (Chen et al., 2020; Sanger et al., 2020). In general, freshly crushed concrete is alkaline, with a pH between 13 and 14 (Daibeer, 2022). Leachates from runoff in direct contact with the RCA may also be as high as pH 13.2 (Daibeer, 2022). Over time however (usually the first 1-2 years of environmental exposure), as cementitious materials in the RCA are carbonated, leachate pH is neutralized (Daibeer, 2022), and “common subgrade soils with moderate clay content” have also been shown to neutralize high pH leachate (Chen et al., 2020). RCA leachate impact can thus vary greatly depending on the original concrete mix, size of crushed aggregate, age/level of carbonation, processing methods, and surrounding soil type (Daibeer, 2022). Given the current, limited understanding of RCA leachates, some sources advise against the use of RCA under

permeable pavement and where run-off or leaching into waterways and groundwater is possible, as well as near sensitive vegetation (ASLA Oregon, 2024).

Though not explicitly studying the effects of concrete leachates and pH, some designers are actively experimenting with soil blends and mulches derived from demolition debris such as concrete and asphalt, to study impacts on plant growth and emergent vegetation (Landezine, n.d.a; Landezine, n.d.b). In all cases where RCA is used as a mulch on plantings however, it is important to consider not only leachates from contact with water, but local climate and the heat tolerance of specific plants, as concrete stores and radiates heat much like natural stone mulch.

The use of RCA in landscape applications offers a promising avenue to significantly minimize landfill waste and carbon emissions generated by landscape construction, and the risks in each situation should be approached on a case-by-case basis, with extra consideration given to sensitive vegetation and groundwater.



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### **3. CASE STUDY – SITE DESIGN**

APPLYING THE REUSE GUIDE TO SITE-SCALE DESIGN



SITE DESIGN OVERVIEW

This case study site design models how to apply the on-site concrete reuse guide to a site-specific project during the concept and early design development phases, in tandem with a design process centering reuse. This process follows a sequence of steps: 1) conducting a site analysis, 2) conducting a site inventory, 3) identifying concrete reuse options, 4) contextualizing reuse options, 5) exploring three different concept design scenarios, and 6) comparing their relative benefits and trade offs.

While this is a speculative design which does not account for many aspects of the site which would normally be considered, such as existing drainage features and underground utilities, the approach could still be translated to real-world landscapes, with those practical issues considered in early site layout and later design development.

SITE SELECTION AND INTRODUCTION

A site was chosen to meet a set of criteria which would allow for the most flexibility in reuse options, and clearly demonstrate the benefits of on-site material reuse within a public-facing context. The landscape must be publicly accessible (even if privately owned) and previously developed, with existing concrete elements, and 1 acre minimum in size. It should be a vacant or underutilized lot which would demonstrably improve human experience and environmental quality if redesigned as a park—parks representing a common type of public-facing landscape which generally require a wide range of different design functions.

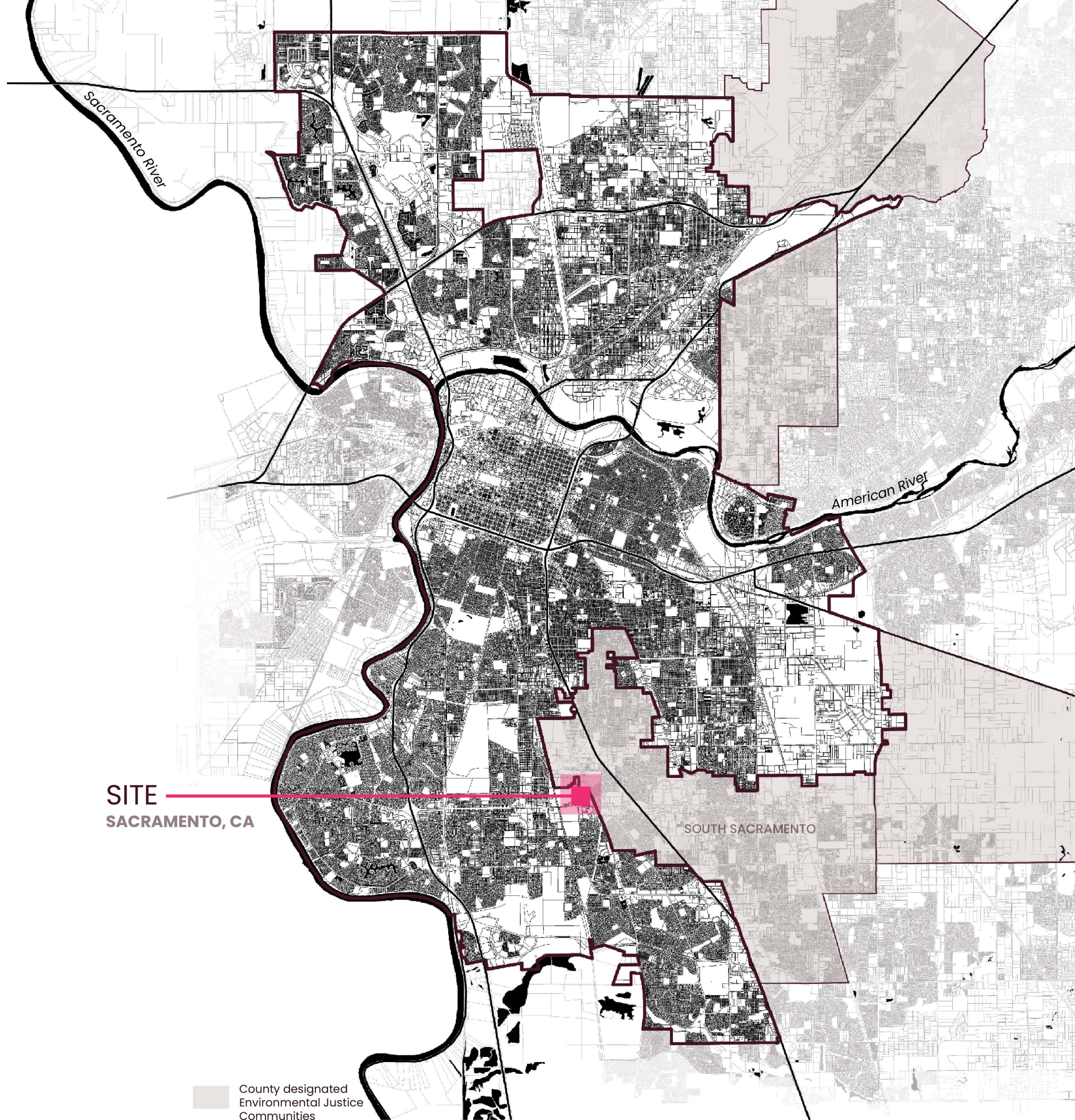
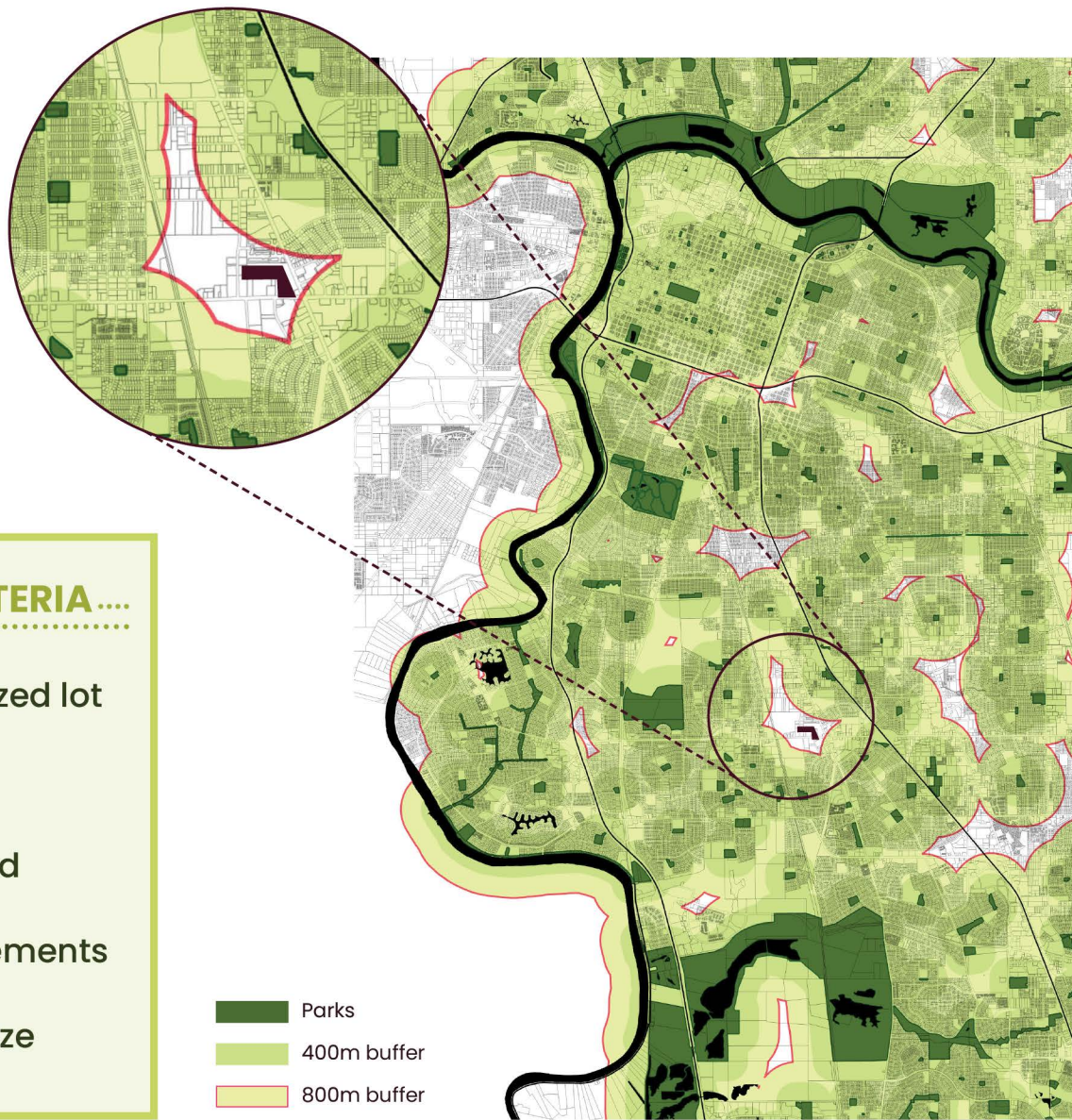
Two adjacent, currently vacant lots in Sacramento, CA were selected for study, considered together as a single site with a total area of 14.4 acres. Sacramento is a sprawling city with primarily car-centric transportation and large amounts of impervious, paved surfaces, providing an excellent opportunity to study concrete salvage and reuse in built landscapes. The vacant lots were identified by first conducting a county-wide park buffer analysis in GIS to identified areas lacking access to parks. The buffer distance was set at 800m (about ½-mile) to represent a 10-minute walk. Satellite imagery within these areas (areas outside the 800m park buffers) was then visually evaluated to identify vacant or underutilized lots with existing concrete elements. At 14.4 acres, it is reasonable to assume that on-site reuse requiring equipment such as portable mills and crushers is viable for this site, and that there would be room to temporarily store salvaged material on-site during construction.

SITE SELECTION CRITERIA ....

- Vacant or underutilized lot
- Publicly accessible
- Previously developed
- Existing concrete elements
- Minimum 1 acre in size



GOOGLE EARTH MAY 2021

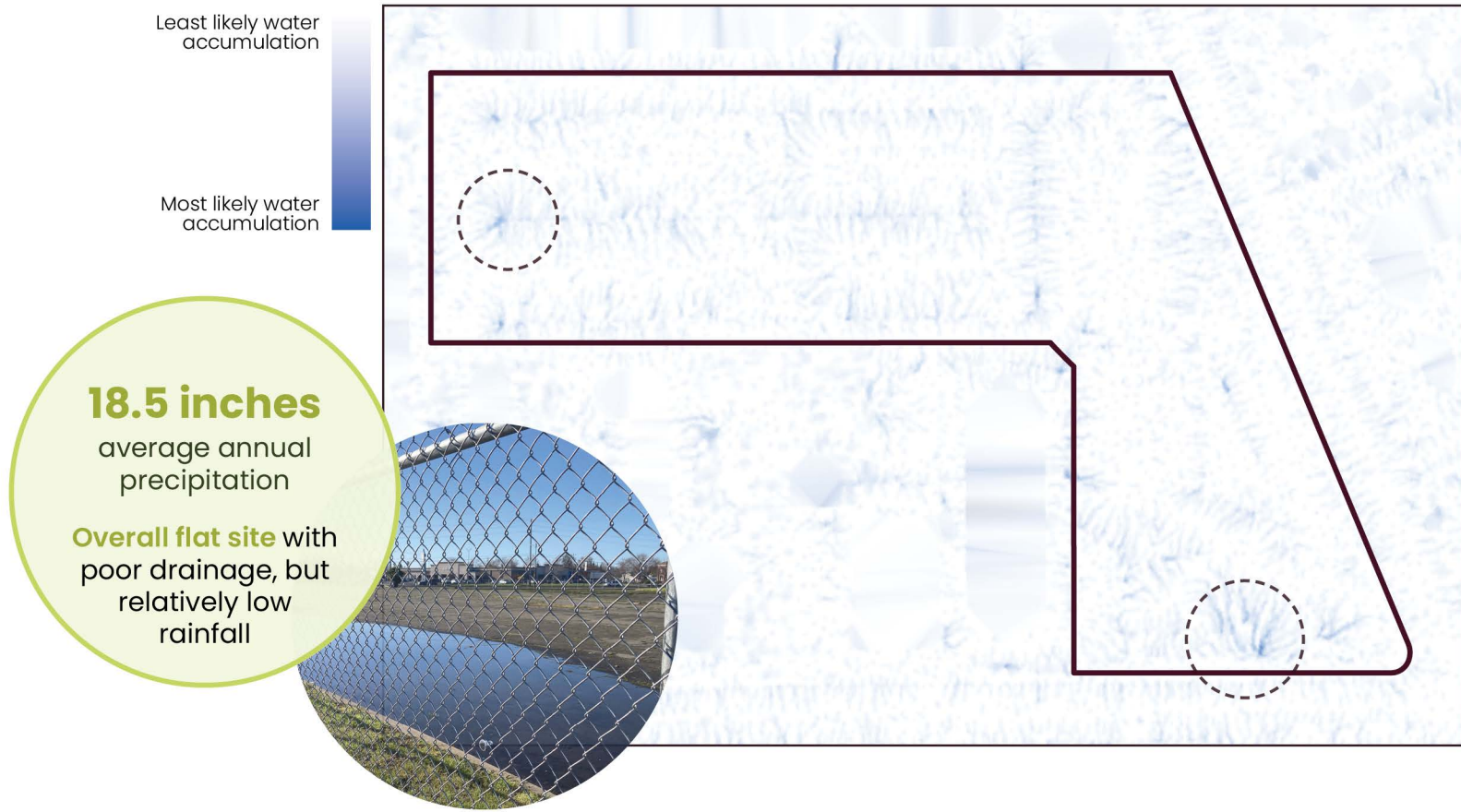


SITE  
SACRAMENTO, CA

0 1 2 4 miles



WATER ACCUMULATION BASED ON SITE TOPOGRAPHY



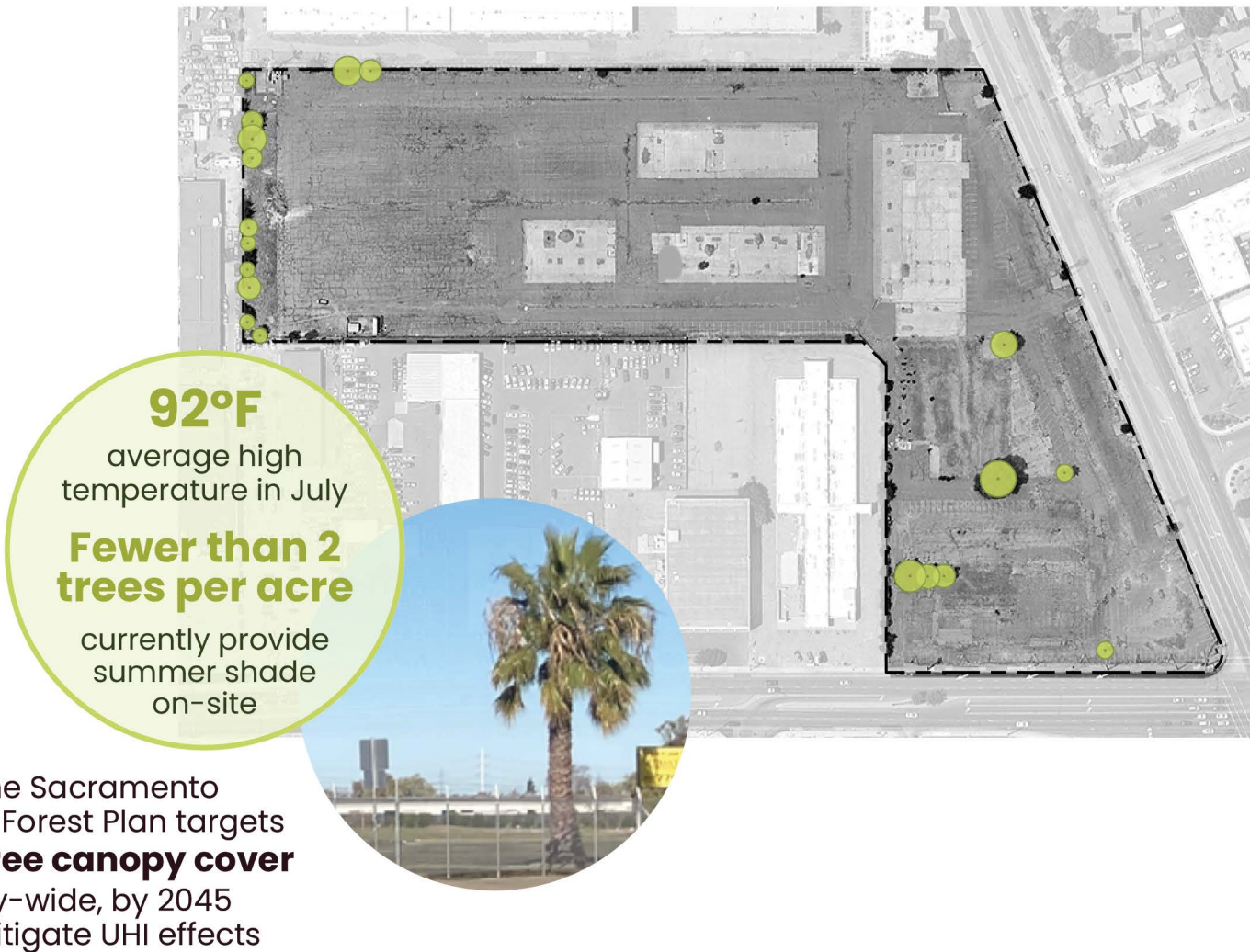
1. SITE ANALYSIS

The site is located in a mixed commercial, residential, and light industrial-zoned area of south Sacramento just at the edge of city limits, bordered by Florin Road to the south and Franklin Boulevard to the east. Both are major, 40mph four-lane roads. Directly across Franklin Blvd. to the east is the county-designated Environmental Justice Community of South Sacramento. There are pedestrian road crossings at the intersection of Florin and Franklin at the southeast corner of the site, north of the site on Franklin Blvd, and west of the site on Florin Rd.

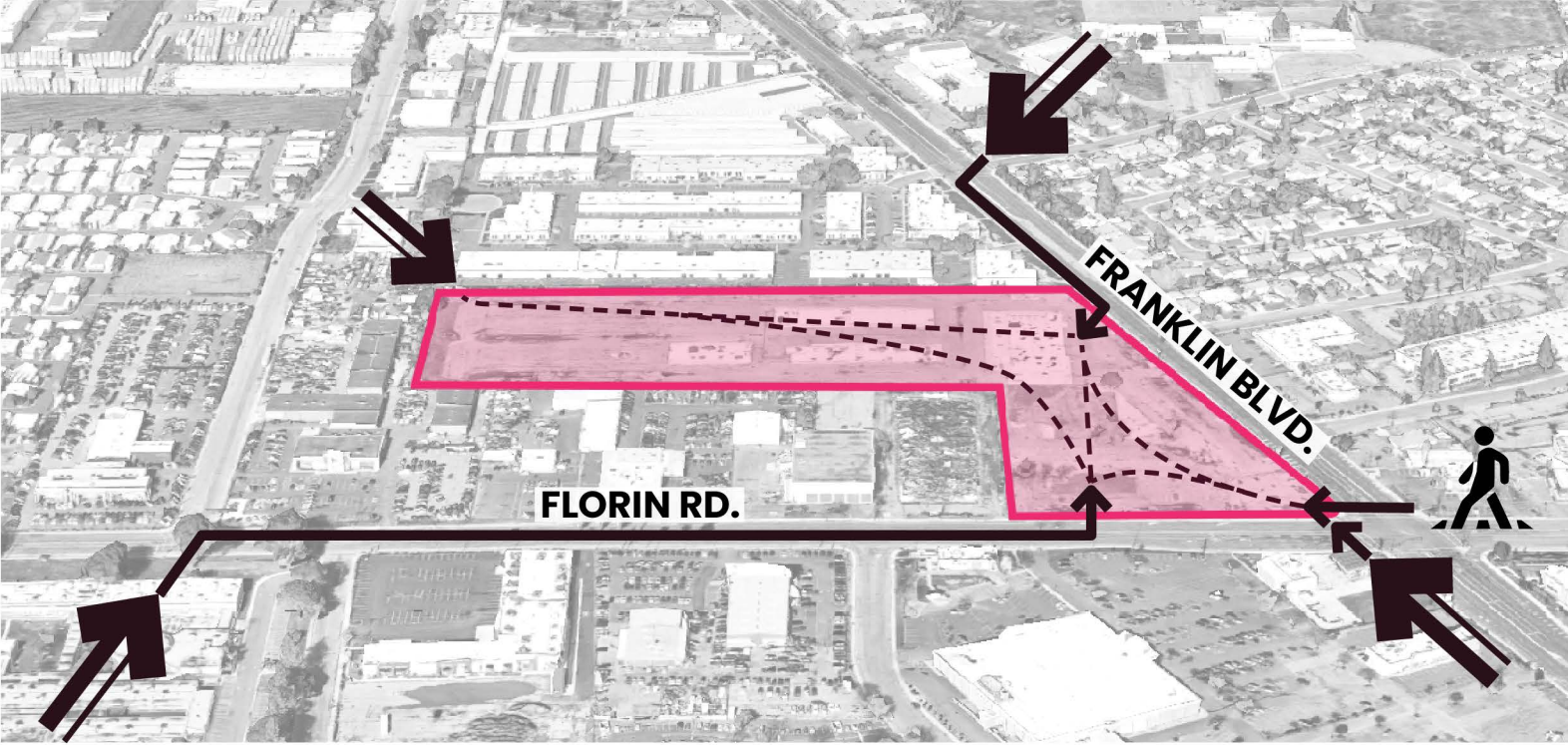
The site is mostly flat and poorly drained. There are likely existing drainage features on-site but they were not surveyed and are beyond the scope of this project. Increasing pervious area on-site would help reduce reliance on constructed drainage features and slow and filter stormwater regardless.

Sacramento's mediterranean climate experiences hot summer weather, with high temperatures in July averaging 92°F (U.S. Climate Data, n.d.). Because of urban heat island (UHI) effects, Sacramento is on average 7.3° hotter than surrounding areas outside the city (Alvarez et al., 2020). Policymakers have made UHI mitigation a priority for the "City of Trees," aiming to increase city-wide urban tree canopy cover to 35% by 2045 (Sacramento Urban Forest Plan, 2024).

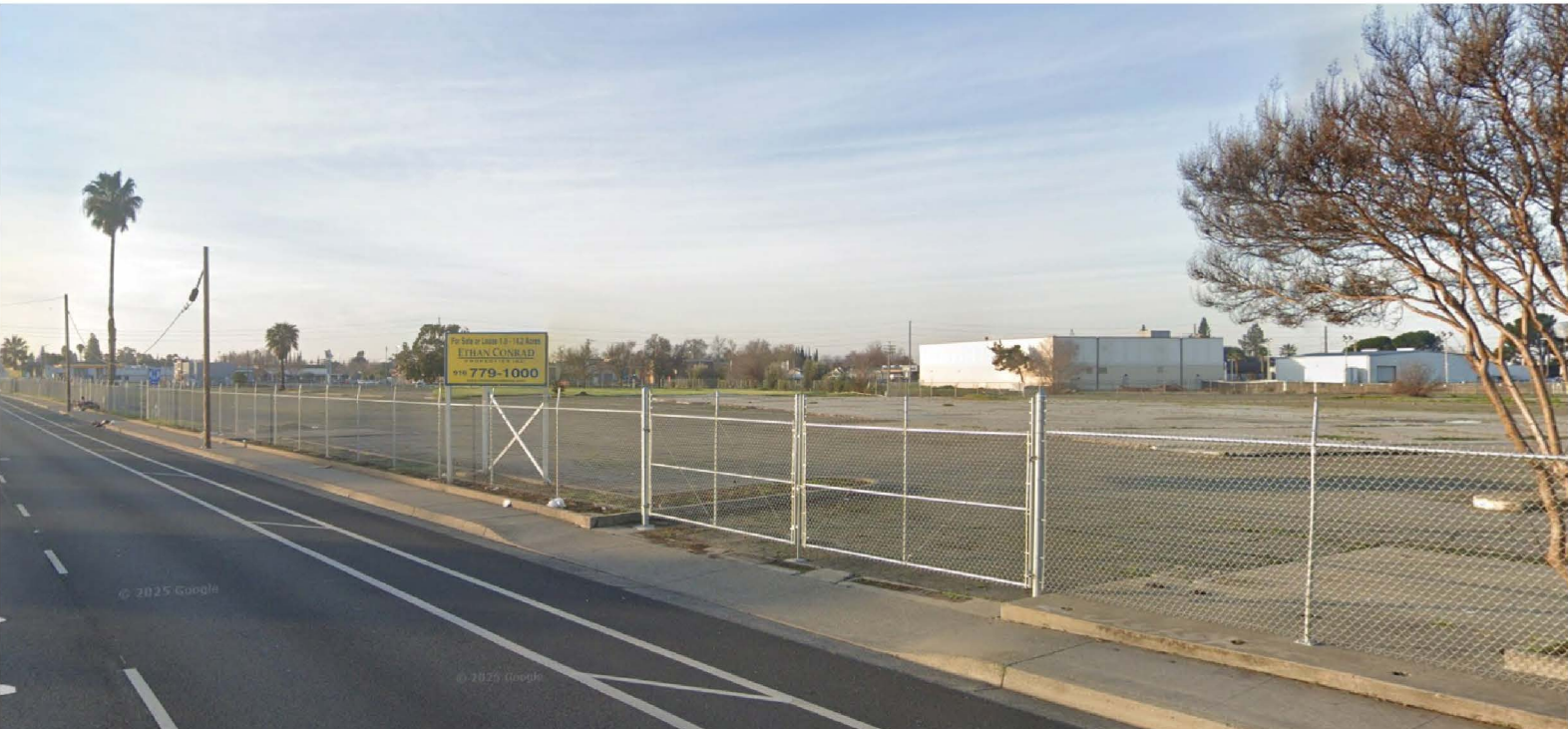
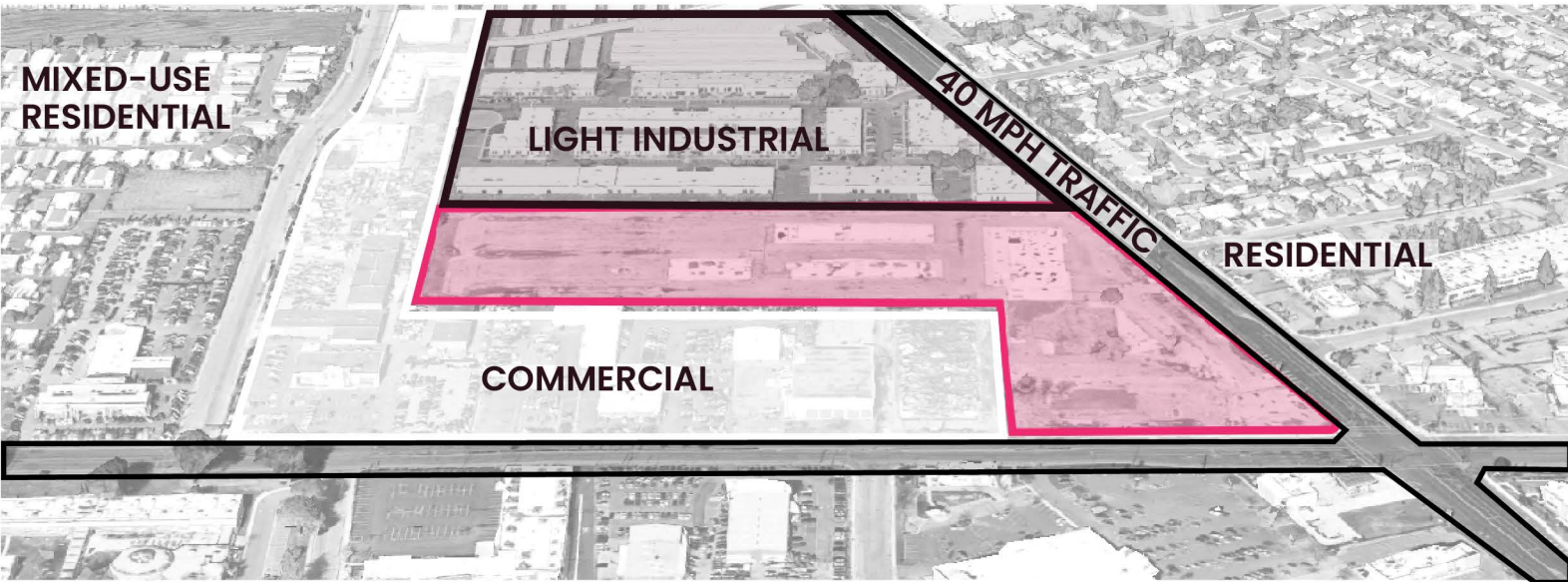
SOLAR & HEAT



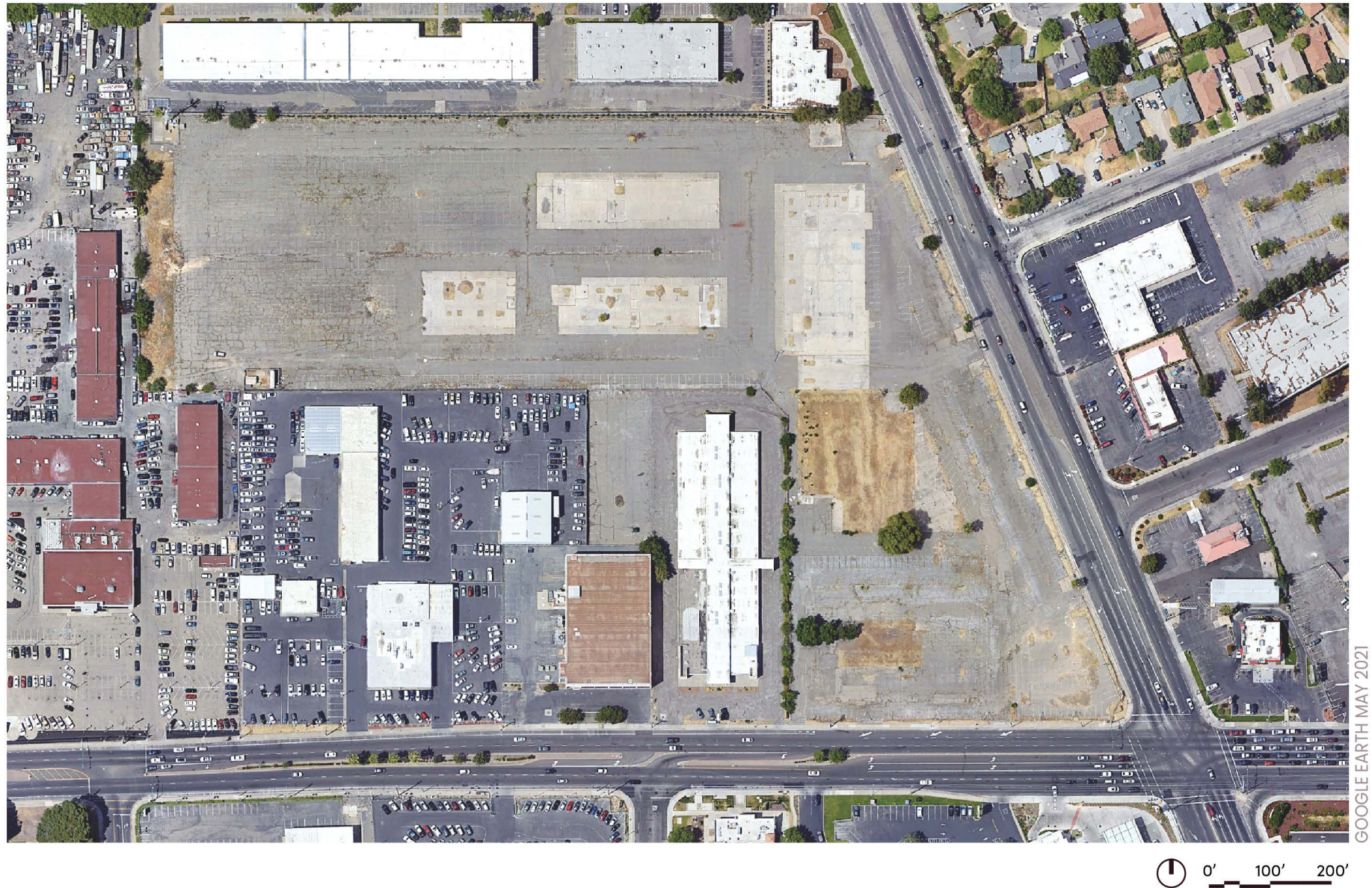
ENTRY POINTS & SHORTEST WALK CONNECTIONS



SURROUNDING CONTEXT







## 2. SITE INVENTORY

Without being able to conduct core drilling or other on-site tests, inventorying existing materials for this site required some assumptions based on context to roughly estimate the volumes and qualities of concrete on-site. The square footage of different paved surfaces was estimated from scaled Google Earth satellite images (2007, 2021, 2023), but their depth and construction had to be estimated based on typical standards and most likely scenarios. Four concrete pads where commercial buildings once stood total 71,400 square feet. These paved areas are assumed to be 6 inches thick and reinforced with rebar, for a total of 35,700 cubic feet of reinforced

cast-in-place (CIP) concrete paving. An additional estimated 30,970 square feet of concrete paving make up former walkways around the building pads, a former parking/entry court area, and six small concrete pads along Franklin Blvd. These paved areas are assumed to be 5 inches thick and unreinforced, for an estimated total of 12,900 cubic feet of unreinforced CIP concrete paving. There are also an estimated 1,750 linear ft of concrete curbs throughout the site or roughly 440 cubic feet of concrete. Other existing surfaces include 64,300 square feet of pervious, vegetated area. Excluding 19 trees, all vegetation appears emergent or ruderal. The rest of the site is covered in asphalt paving.



— — — SITE BOUNDARY

### EXISTING CONCRETE

|  |                              |                              |
|--|------------------------------|------------------------------|
|  | <b>71,400 ft<sup>2</sup></b> | REINFORCED CONCRETE PAVING   |
|  | <b>30,970 ft<sup>2</sup></b> | UNREINFORCED CONCRETE PAVING |
|  | <b>1,750 ln ft</b>           | CAST-IN-PLACE CONCRETE CURBS |

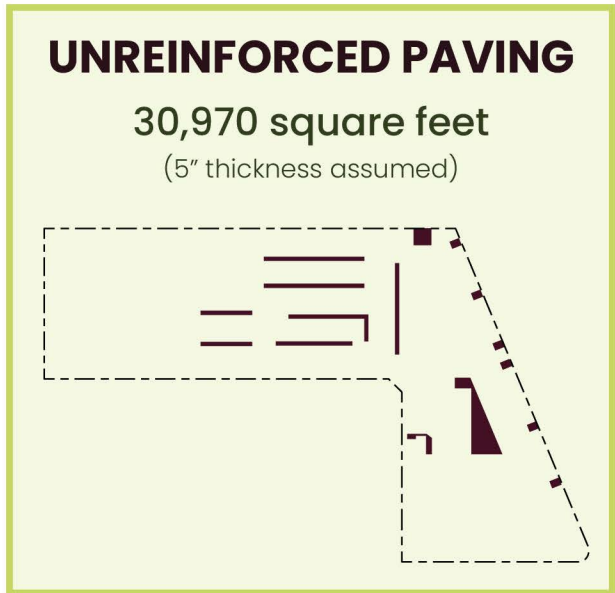
### OTHER EXISTING MATERIALS

|  |                              |                    |
|--|------------------------------|--------------------|
|  | <b>64,300 ft<sup>2</sup></b> | PERVIOUS LANDSCAPE |
|  | EXISTING TREE (19)           |                    |

### 90% IMPERVIOUS LAND COVER



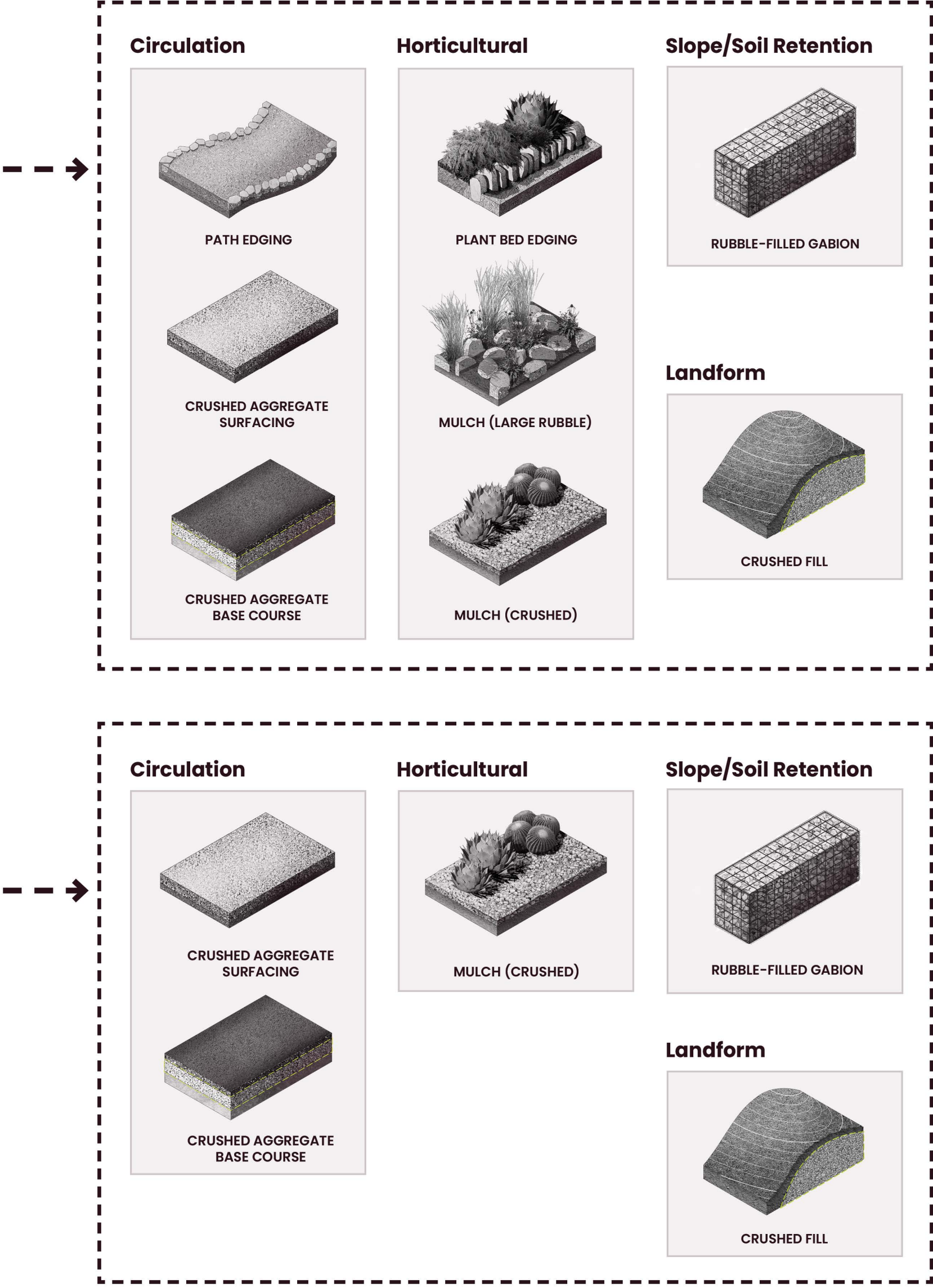
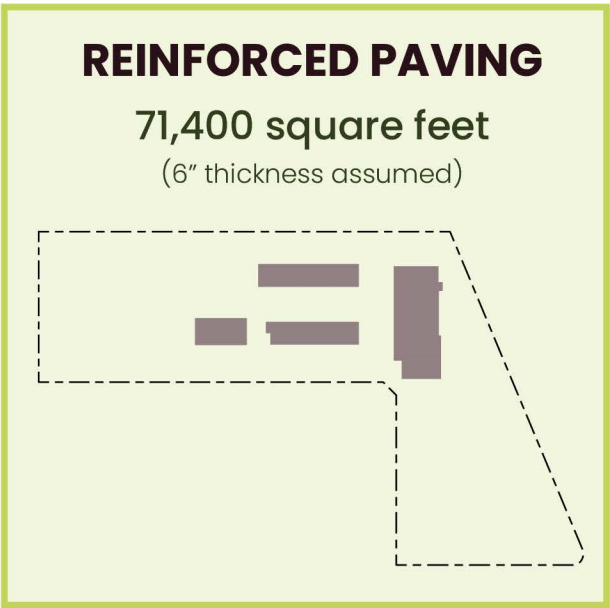
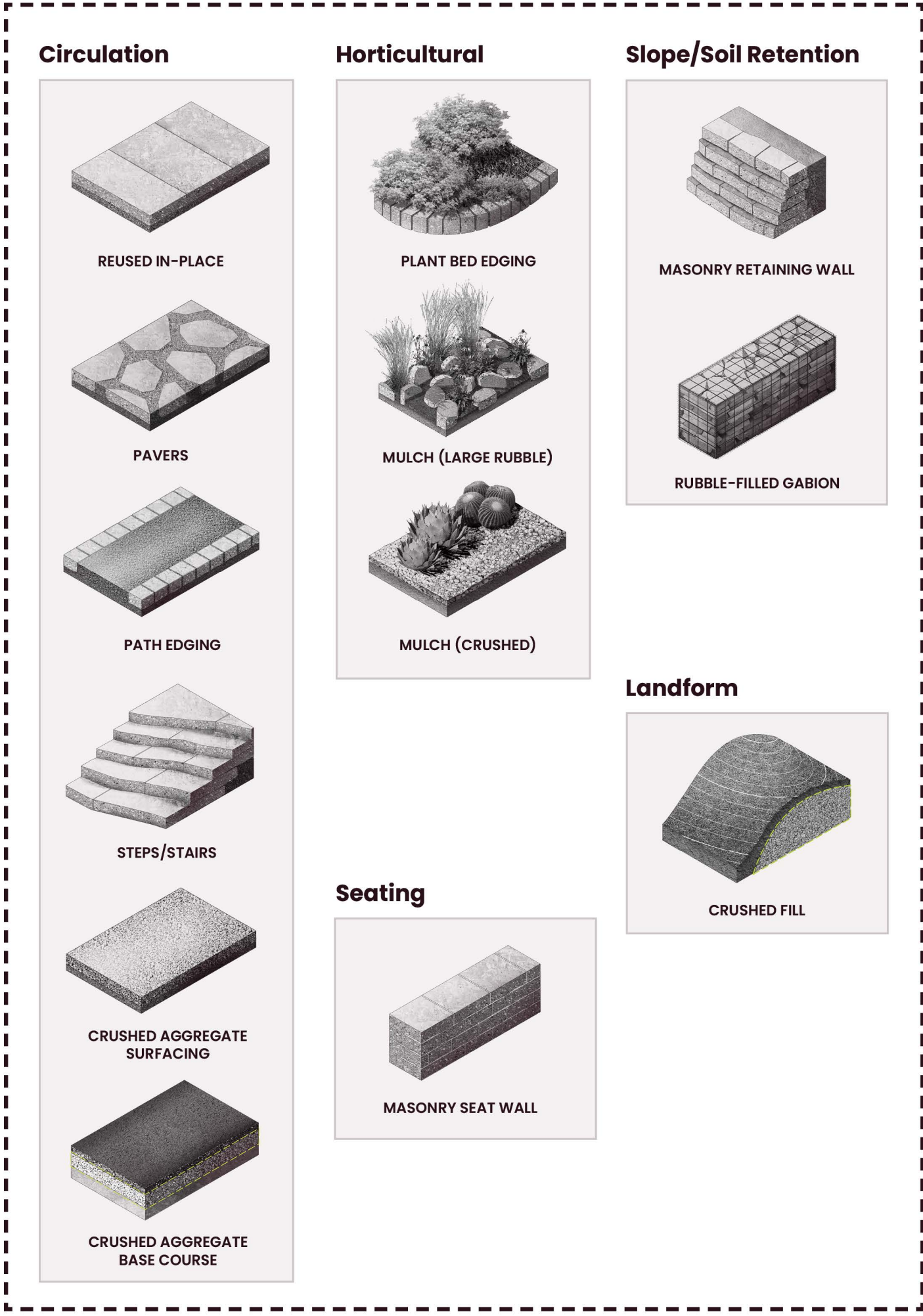




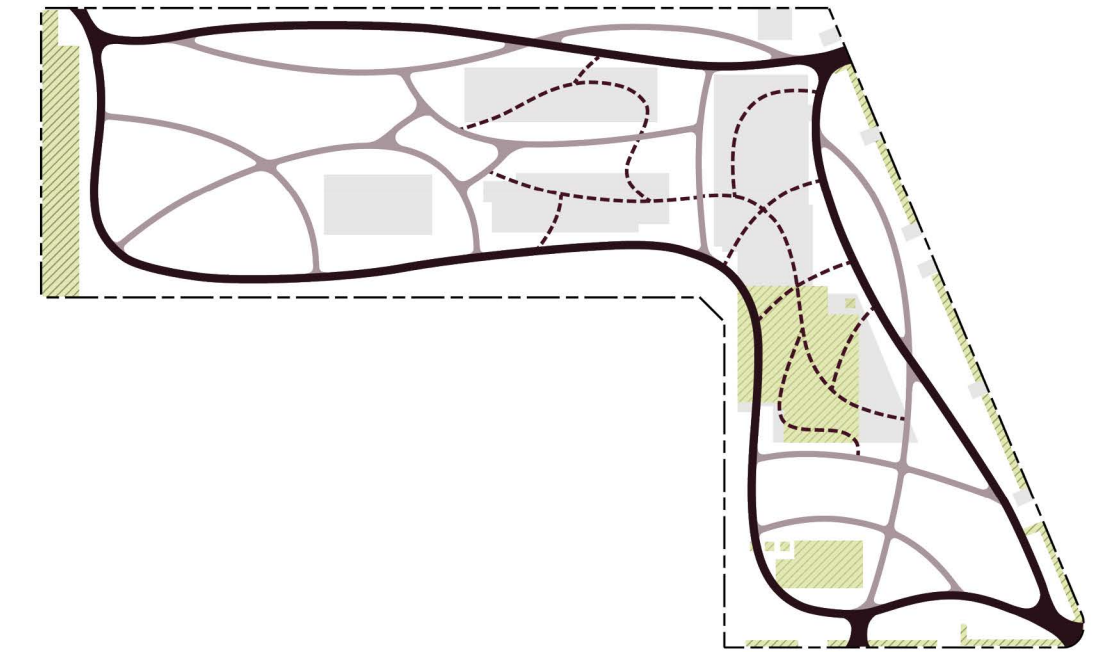
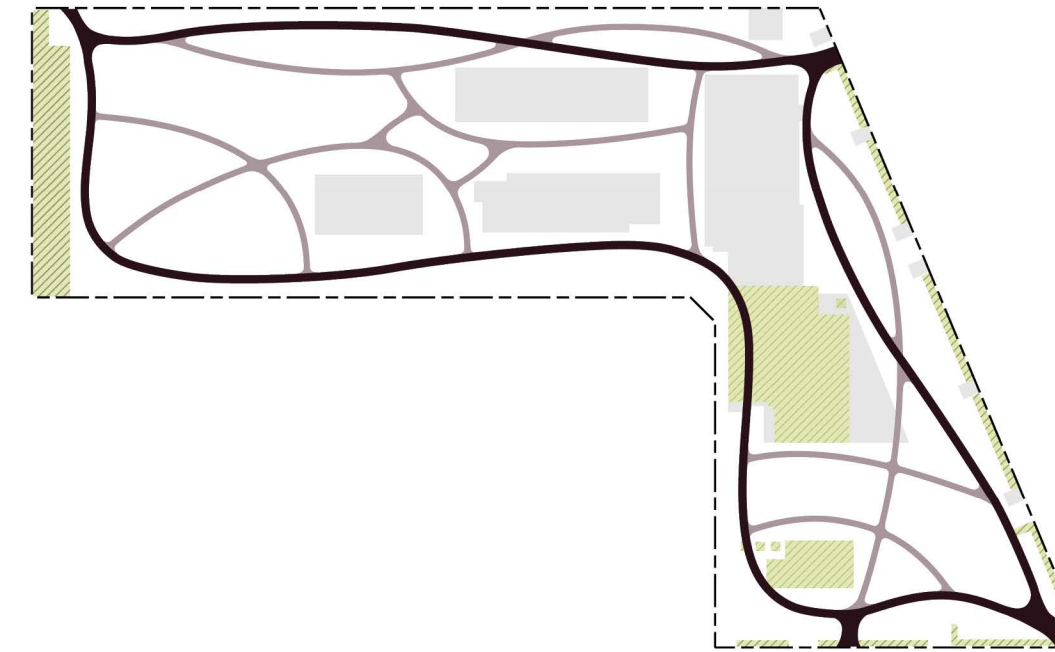
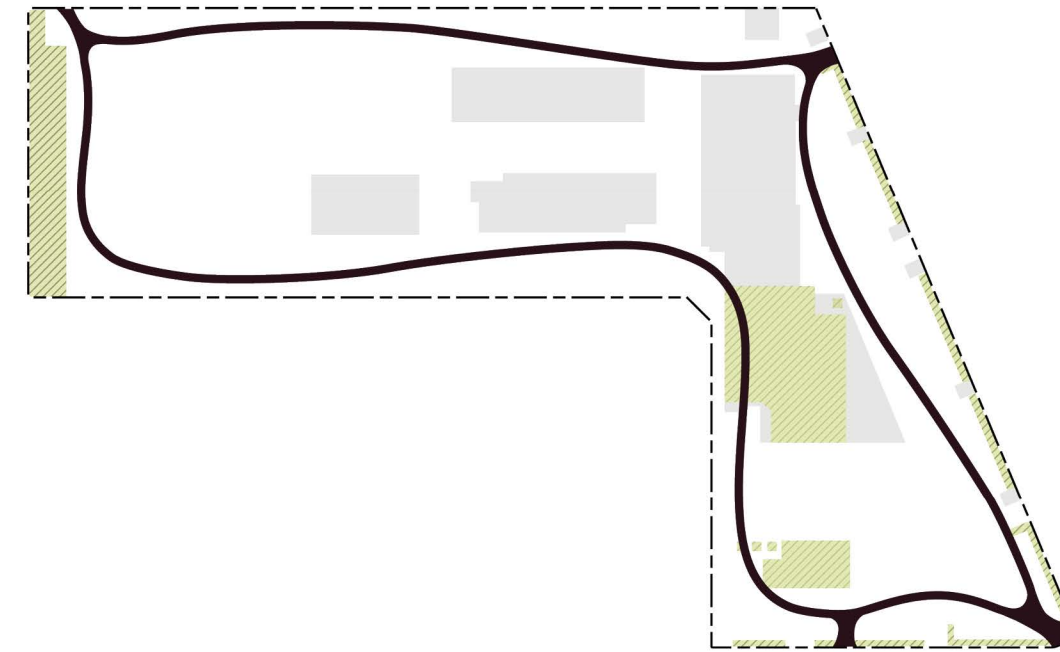
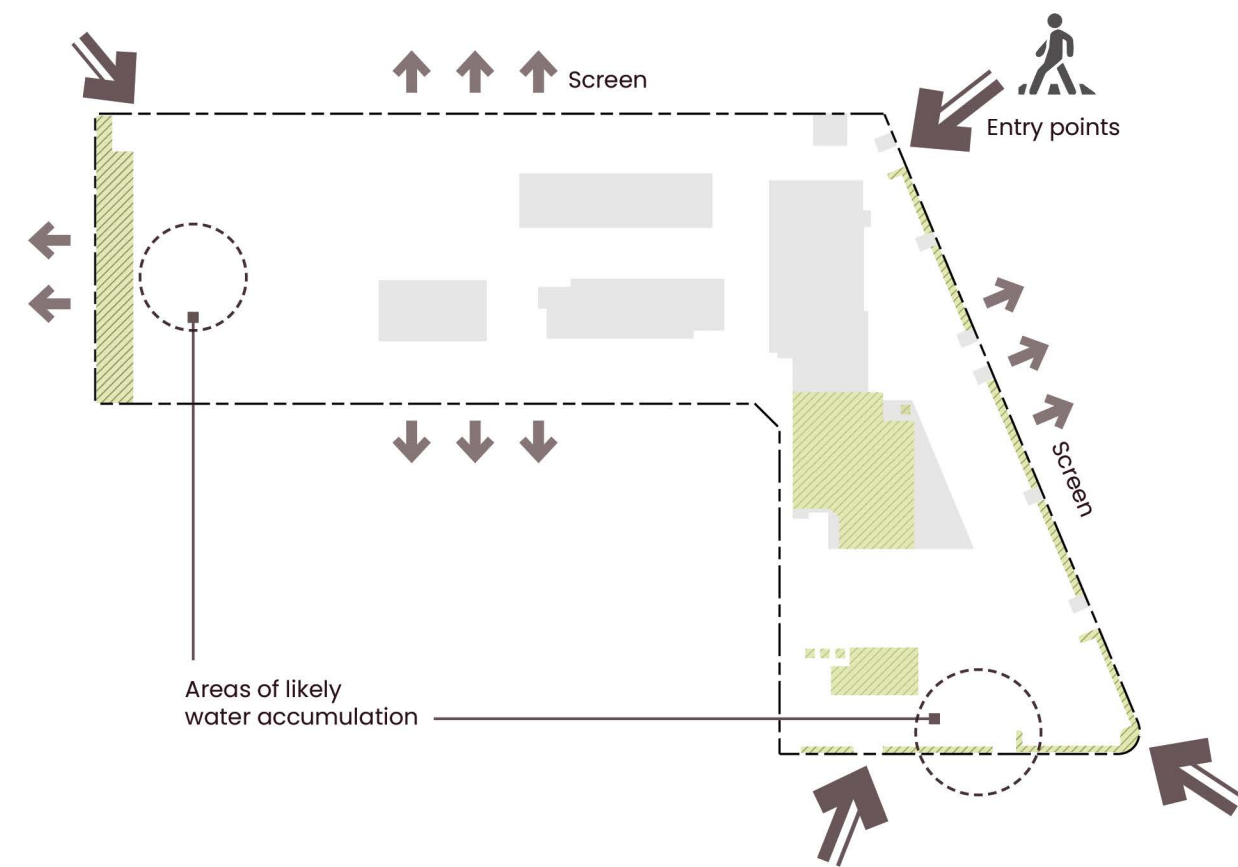
REINFORCED CONCRETE PAVING  
 UNREINFORCED CONCRETE PAVING  
 CAST-IN-PLACE CONCRETE CURBS

### 3. IDENTIFYING CONCRETE REUSE OPTIONS

The concrete reuse guide provides a quick reference for what could be done with the existing concrete if kept on-site and reused in a new landscape. Of the three different forms of existing concrete, the unreinforced paving offers the most reuse options.







#### Existing Materials and Condition



#### Primary Circulation

10' WIDE ADA ACCESSIBLE PATHS



#### Secondary Circulation

8' WIDE ADA ACCESSIBLE PATHS



#### Tertiary Circulation

6' WIDE REUSED CONCRETE PATHS



CONCRETE PAVING

too damaged to reuse in-place  
↓  
remove and salvage for other uses



ASPHALT PAVING

reuse in-place  
↓  
recycle off-site what can't be reused on-site



LANDSCAPE AREAS

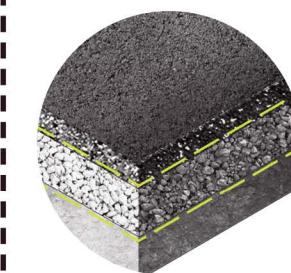
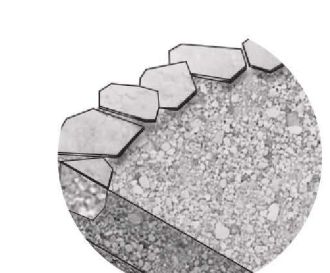
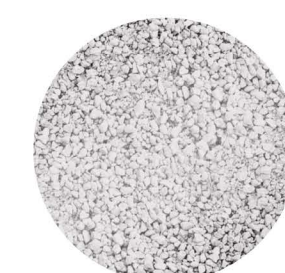
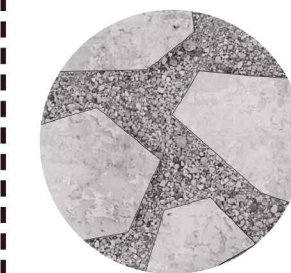
preserve and expand



.75 mile loop created almost entirely by **resurfacing existing asphalt in-place**



**Additional existing asphalt resurfaced in-place** to expand path options



**Reuse salvaged concrete** for circulation in areas where paving must be removed

↑ **ON-SITE REUSE OPTIONS FOR CIRCULATION**

#### 4. CONTEXTUALIZING REUSE OPTIONS

Site conditions, surrounding context, and design intent all influence decision-making around concrete reuse. In this case study, a large amount of existing asphalt paving and the poor condition of existing concrete slabs influence the proposed circulation layout, which aims to efficiently connect site entry

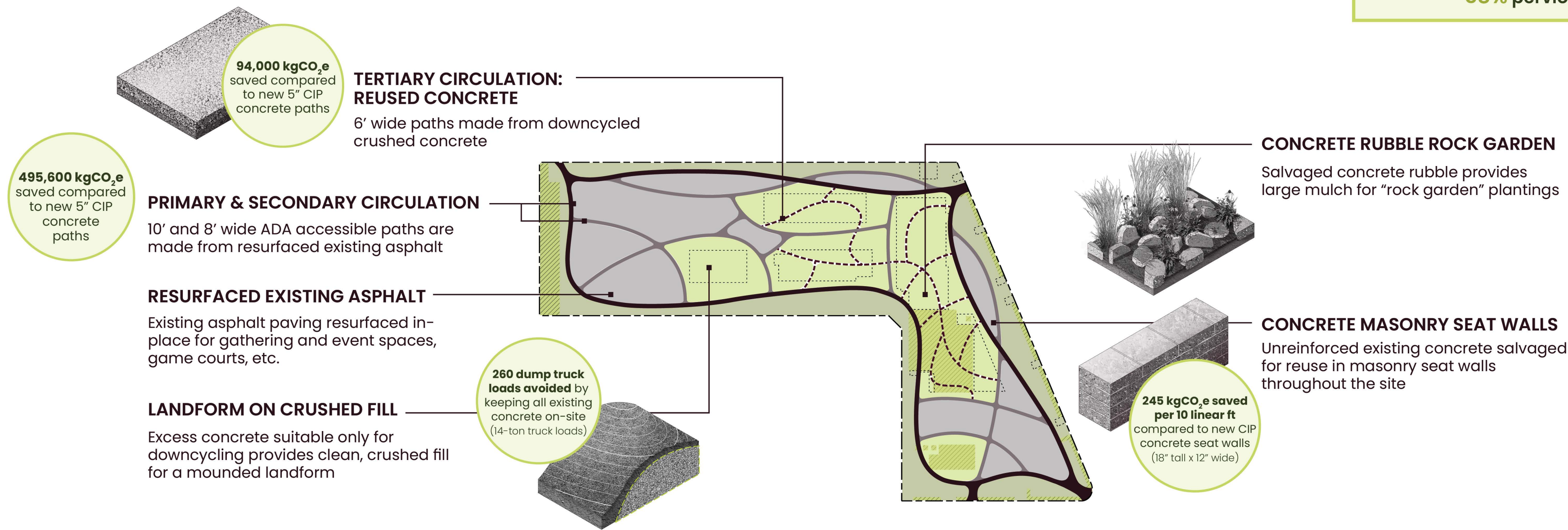
points while keeping as much material on-site as possible, including all existing concrete.

In this case the existing concrete cannot be reused in-place because it is too damaged. However, the existing asphalt can be resurfaced to create accessible paths, and the concrete removed and salvaged for other uses on-site, including other

forms of surfacing material for tertiary circulation to supplement the resurfaced asphalt paths. Existing pervious landscape areas can be preserved and expanded to increase overall site perviousness, mitigate UHI effects, and provide planted screening around the park's periphery.



**DESIGN SCENARIO 1: MOST MATERIAL KEPT ON-SITE**  
MINIMIZES LANDFILL WASTE AND EMISSIONS FROM TRANSPORTATION AND PROCESSING  
BY LIMITING DEMOLITION AND NEW CONSTRUCTION



**62%** of total paving material kept on-site  
**100%** of concrete reused on-site in 4 different ways  
**5.7x** increase in planted area over existing  
**58%** pervious land cover

**5. CONCEPT DESIGN SCENARIOS**

Three different concept designs explore various options for on-site concrete reuse in a neighborhood park. All design scenarios commit to reusing 100% of existing concrete on-site, while supporting goals impact the specific ways in which the concrete is reused. The first scenario seeks to minimize emissions by keeping as much material on-site as possible and limiting construction. The second scenario increases pervious landscape area, and the third scenario

incorporates additional reuse strategies to visibly showcase concrete reuse.

Site-scale design decisions around concrete reuse directly influence the amount of processing and construction required, in turn impacting both project cost and carbon savings potential. The relative benefits and trade offs of all three design scenarios, including cost, carbon, benefits from vegetation, and overall waste diversion, are compared on page 85.

- Site Boundary
- Existing Concrete Paving
- Existing Pervious Area
- Resurfaced Asphalt Paving
- Planted Area
- Screening Plantings



DESIGN SCENARIO 2: MOST PERVIOUS SURFACE COVER

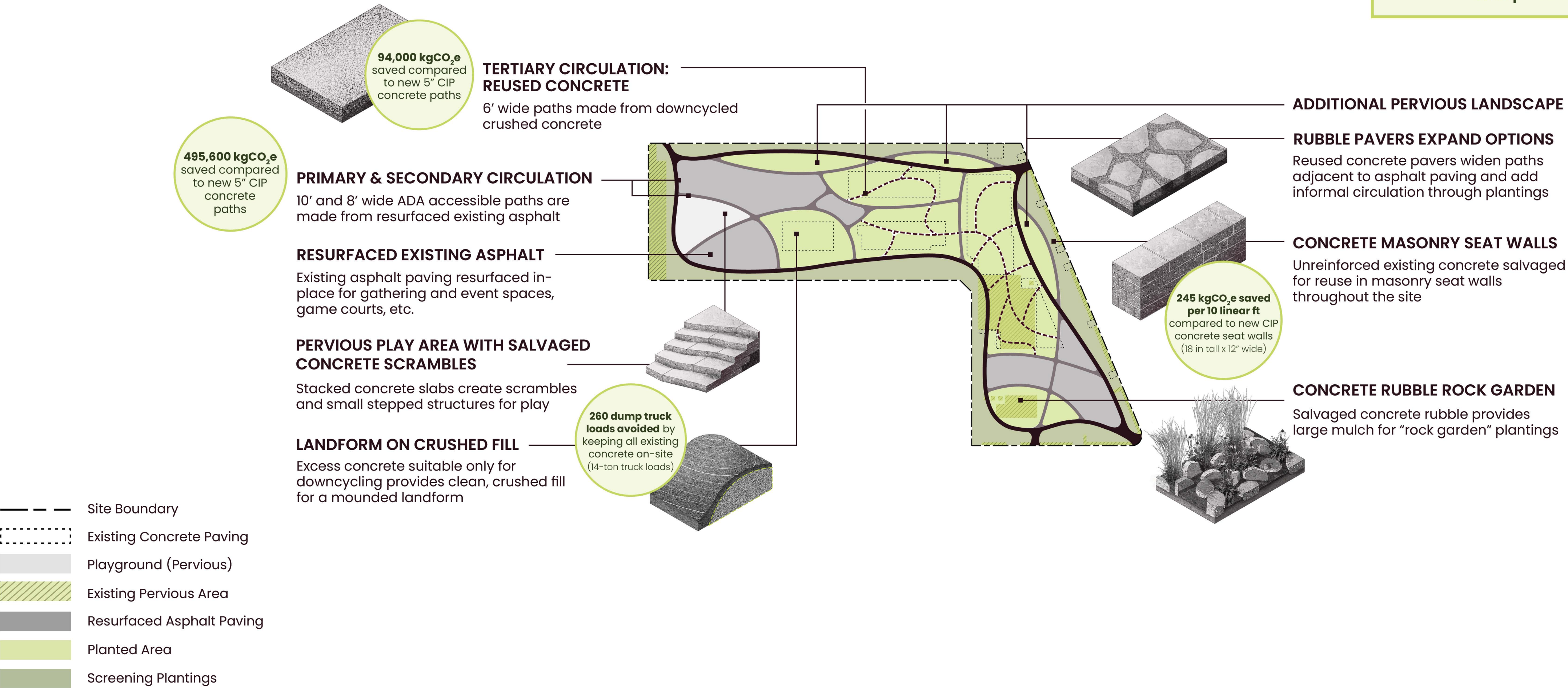
MAXIMIZES VEGETATED LANDSCAPE AREA TO INCREASE CARBON SEQUESTRATION AND STORAGE, PROVIDE HABITAT AND SUMMER COOLING, AND IMPROVE STORMWATER INFILTRATION

51% of total paving material kept on-site

100% of concrete reused on-site  
in 6 different ways

6.3X increase in planted area over existing

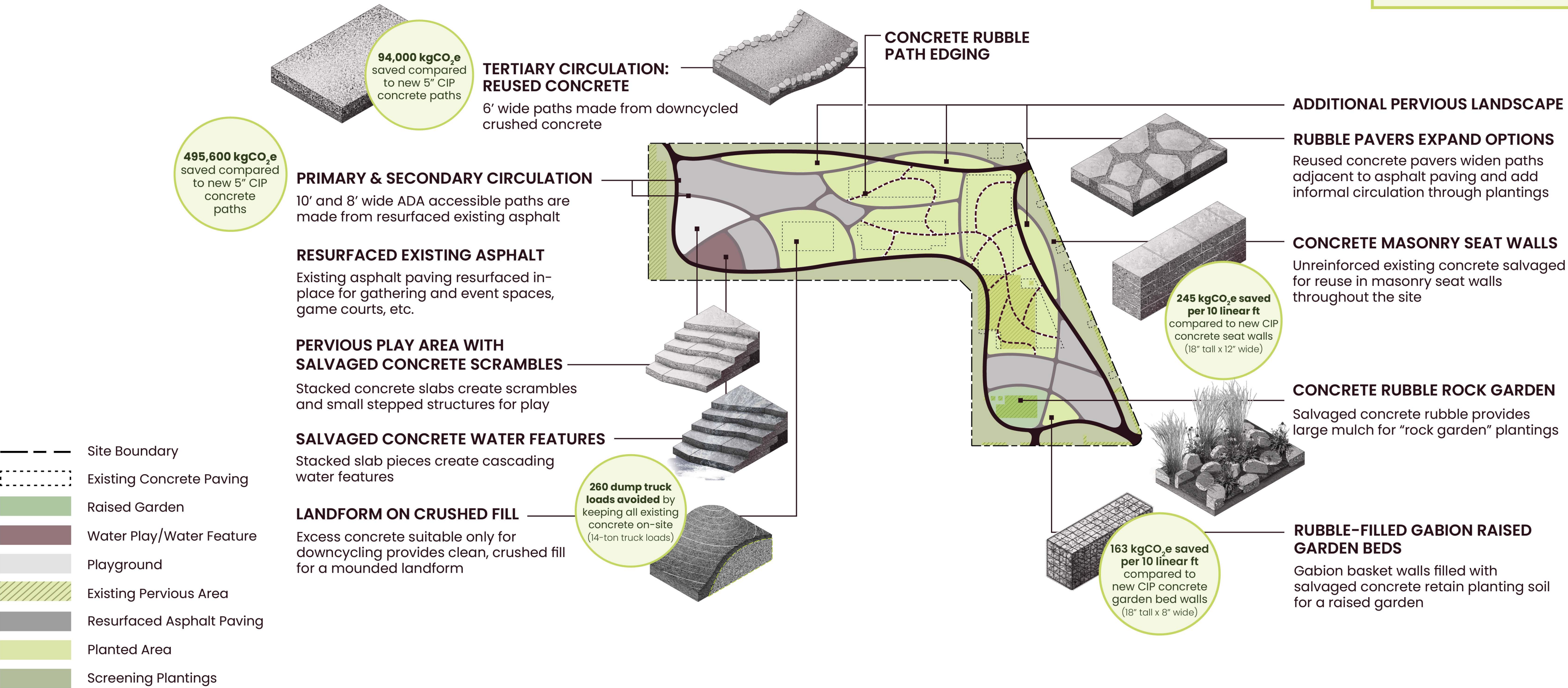
67% pervious land cover





DESIGN SCENARIO 3: MOST VARIETY IN REUSE  
SHOWCASES A WIDE RANGE OF CONCRETE REUSE STRATEGIES

50% of total paving material kept on-site  
100% of concrete reused on-site  
in 9 different ways  
6.3x increase in planted area over existing  
65% pervious land cover





6. DESIGN SCENARIO COMPARISON

Decisions around concrete reuse in built landscapes require weighing both benefits and trade-offs, dependent on what design goals the project hopes to optimize. The scenarios here optimize keeping material on-site, increasing pervious land cover, or showcasing reuse variety, and arguments could be made both in favor of and against each of them. Overall however, Scenario 2 effectively balances a moderate amount of project construction with environmental benefits and reuse variety. While perhaps less exciting than Scenario 3, the simpler design keeps the budget smaller, and reduces processing and construction emissions. The absense of water features will also help conserve water in Sacramento’s hot summer climate and reduce maintenance and operational emissions compared to Scenario 3. Although replacing more asphalt surface with vegetative areas and plantings will help mitigate heat island effects and increase carbon sequestration and storage over time, the trade-off for these improvements over Scenario 1 is higher transportation emissions from hauling asphalt offsite.

This comparison draws attention to major thematic categories of on-site concrete reuse impact (vegetation, cost, carbon, and waste) to help illustrate key considerations in a design process centering material reuse. Lifecycle assessment tools like *Carbon Conscience* and *Pathfinder 3.0* can provide numerical data to understand more precise impacts, benefits, and trade-offs of design decisions.

SCENARIO 1: MOST MATERIAL KEPT ON-SITE

|            | BENEFITS                                                                                           | TRADE-OFFS                                                                                          |
|------------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| VEGETATION |                                                                                                    | <b>Least vegetative cover</b><br><b>Worst heat island effects</b><br><b>Most impervious surface</b> |
| COST       | <b>Lowest cost</b><br>Likely cost savings compared to construction with all new materials          |                                                                                                     |
| CARBON     | <b>Lowest construction emissions</b> from minimal material processing, installation, and transport | <b>Least carbon sequestration</b> by plants                                                         |
| WASTE      | <b>Most demolition material diverted</b> from landfills<br>All concrete kept on-site               |                                                                                                     |

SCENARIO 2: MOST PERVIOUS SURFACE COVER

|            | BENEFITS                                                                                                                            | TRADE-OFFS                                                                            |
|------------|-------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| VEGETATION | <b>Most vegetative cover</b><br><b>Best heat island mitigation</b><br>Increased pervious area and <b>best stormwater management</b> |                                                                                       |
| COST       | Possible cost savings compared to construction with all new materials                                                               | <b>Moderate cost</b> – more material processing and construction                      |
| CARBON     | <b>Lower emissions</b> compared to construction with all new materials<br><b>More carbon sequestration</b> by plants                | Higher transportation emissions from asphalt removal<br>Higher construction emissions |
| WASTE      | All concrete kept on-site                                                                                                           | Some demolition material recycled off-site                                            |

SCENARIO 3: MOST VARIETY IN REUSE

|            | BENEFITS                                                                                                           | TRADE-OFFS                                                                                                                                                                       |
|------------|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VEGETATION | More vegetative cover<br>Better heat island mitigation<br>Increased pervious area and better stormwater management | Slightly less pervious area for stormwater management                                                                                                                            |
| COST       |                                                                                                                    | <b>Highest cost</b> – most material processing and construction<br>Cost savings compared to construction with all new materials possible but less likely than in Scenarios 1 & 2 |
| CARBON     | Lower emissions compared to construction with all new materials<br><b>More carbon sequestration</b> by plants      | Higher transportation emissions from asphalt removal<br><b>Highest construction emissions</b><br>Higher anticipated <b>maintenance and operational emissions</b>                 |
| WASTE      | All concrete kept on-site                                                                                          | Some demolition material recycled off-site                                                                                                                                       |





**590,000 kgCO<sub>2</sub>e**  
emissions avoided by reusing  
existing material for paths  
compared to new 5" cast-in-place  
concrete paving  
(does not account for asphalt  
resurfacing emissions)

**LANDFORM ON CRUSHED  
CONCRETE FILL**

Adds gentle topography to an  
otherwise flat site, while diverting  
leftover concrete from the landfill

**50 kgCO<sub>2</sub>e**  
saved per 10 square feet  
compared to new, 60mm  
precast concrete unit pavers  
sourced within 100 miles  
(100% paver coverage)

**PAVERS MADE FROM  
CAST-IN-PLACE CONCRETE**

Expand path width and supplement  
ADA accessible resurfaced asphalt

**SEAT WALLS MADE FROM  
UNREINFORCED PAVING**

Saw cut into masonry units

**245 kgCO<sub>2</sub>e**  
saved per 10 linear feet  
compared to new cast-in-  
place concrete seat walls  
(18" tall x 12" wide)

**94,000 kgCO<sub>2</sub>e**  
saved compared to new  
5" thick cast-in-place  
concrete paving  
(13,800 ft<sup>2</sup>)

**CRUSHED CONCRETE  
AGGREGATE PATHS**

Add circulation through planted areas  
where former paving was removed,  
keeping the material on-site

**7. SITE DESIGN VISUALIZATION**

Carbon savings were calculated in *Pathfinder 3.0* and represent rough estimates only. New cast-in-place concrete alternatives assume 3,000–4,000 psi portland cement concrete type 1 or 2 with no SCMs, transportation by truck from within a 10 mile radius.



## CONCLUSION

Material reuse is not yet a standard practice in the landscape industry, and suggestions to salvage and reuse existing concrete are often met with counter-arguments and push back—it is too costly, it is too complicated, it is not what the client had in mind. Mostly though, it is just too unfamiliar.

Yet landscape architects have already successfully salvaged and reused concrete in creative, practical, and compelling ways. With reused concrete they have achieved many of our most common landscape needs, and in some cases even reduced cost, collectively demonstrating that concrete reuse is both possible and a promising strategy going forward, as we work to decarbonize our built landscapes and divert waste from landfills.

Building upon these precedents and the body of recent research and tools developed specifically for landscape architects working to cut carbon and improve sustainability in the field, this project contributes pragmatic, site-scale reuse strategies for concrete and a revised framework for approaching materials found on-site. All too often existing material is demolished and removed; it is time to start thinking about this material instead as “existing to be reused.”





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