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Green Stormwater Infrastructure on Vacant Lots

The benefits that urban green space provides to cities have been well documented. It reduces expenditures for vital services such as air filtration, stormwater management, and temperature regulation.[1] Urban green space adds value to nearby properties, increases commerce, and reduces violent crime. It improves human health outcomes[2] by reducing stress,[3] encouraging exercise,[4] and reducing illness and death from respiratory disease. The Vacant to Vibrant project was inspired to bring these benefits to areas where they could assist with neighborhood stabilization. We created a project to build urban green space on small vacant parcels in three post-industrial cities with the goal of improving the environmental and social fabric of neighborhoods.

Vacant to Vibrant began as a hashtag, #vacant2vibrant, used to organize conversations over a series of interdisciplinary meetings in 2009 and 2010.[5] Dozens of professionals from city government, sewer/stormwater authorities, and urban greening organizations from 11 Great Lakes cities met to characterize shared problems that were emerging as state and federal monies were being invested in blight removal and demolition of abandoned buildings, creating growing catalogs of vacant lots. We wanted to understand existing vacant land reuse efforts and explore how these might complement environmental initiatives that were taking place in the same cities.

From this process, the group identified three areas of need that were common to many urban areas in the Great Lakes region:

- Large quantities of vacant land that were unproductive and expensive to maintain

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- Outdated sewer systems that were creating a need for better stormwater management in the face of a changing climate
- Neighborhoods that had weathered the environmental and social effects of decades of industrial decline

Vacant to Vibrant drew upon innovative vacant land reuse work that had been undertaken in many places around the US, such as pocket parks, green stormwater infrastructure, urban farming, and "clean-and-green" neighborhood stabilization projects. While its primary focus was finding a way to use vacant lots to benefit the Great Lakes ecosystem, Vacant to Vibrant differed from many environmental projects that were being implemented at the time in its equal emphasis on the social and the environmental needs of urban neighborhoods. Its effort to combine vacant land reuse, green stormwater infrastructure, and neighborhood revitalization tested whether land use strategies could be stacked within the small footprint of a single lot.

The project included beautification of three vacant parcels in one neighborhood in each of three Great Lakes cities—Gary, Indiana; Cleveland, Ohio; and Buffalo, New York. We targeted declining neighborhoods that could benefit from stabilization and set out to develop modest urban greening approaches that were customized to the needs of those neighborhoods. Rain gardens were added to each parcel, as well as landscaping or equipment that supported a recreational use for residents. The type of recreation varied from very passive, such as walking, bird-watching, or picnicking, to more active, such as handball or active play. Where possible, flower beds and low-maintenance plants replaced lawn to reduce mowing requirements and add habitat. In the interest of replicability, we strived for modest projects with installation costs ranging from \$7,000 to \$35,000 (average: \$18,000) over nine installations.

This approach contrasted with large stormwater management projects that were being undertaken in Milwaukee, Chicago, and Cleveland on aggregated vacant land. It also contrasted with green streets and smaller stormwater management projects that were being constructed in stable or gentrifying neighborhoods in many cities throughout the US. Beyond the construction of projects themselves, Vacant to Vibrant was an attempt to document processes and lessons that could help lead to systemic change—change that would be necessary if cities want to grow green stormwater control up to the level of "infrastructure." The three cities provided separate examples of how manufacturing cities are grappling with adapting old systems to new, green technology.

In this chapter, we explore how population loss that created thousands of acres of vacant land also contributed to letting underlying urban infrastructure fall out of date. As a result, cities with a shrinking base of tax- and ratepayers are contending with large sewer infrastructure updates for regulatory compliance. Examining these two problems in tandem may suggest where and what form joint solutions might take to repurpose vacant lots for the benefit of environmental quality.

Excess Urban Vacant Land

In the late 19th and early 20th centuries, US cities boomed with the spread of industrialization. Near the Great Lakes, where expansive bodies of freshwater fueled production and provided access to international shipping routes, cities rapidly expanded under steel and manufacturing. Large cities annexed smaller towns and undeveloped land to support an influx of residents from the East, rural areas, and abroad. They laid roads, sewers, and other infrastructure in an expanding urban grid. When rivers and beaches blackened and caught fire, their loss was a cost of progress.

After the demands of World War II ended and manufacturing slowed in the region, city economies began shifting away from heavy industry. On the Canadian side, early economic diversification to embrace light industry, tech, and service sectors spurred population growth in the 1970s that continues to this day.[6] A short drive across the border into Detroit or Buffalo, however, shows that Great Lakes cities on the US side did not adapt as quickly. Job loss caused by automation and imports was exacerbated by US racial politics. Desegregation of schools and neighborhoods fed white flight and urban sprawl that gutted downtowns and permanently altered the demographics of urban neighborhoods.

Many American post-industrial cities continued to lose population from the 1960s onward. In some cities, the pattern of population loss was widespread across most of their land area (Detroit, Gary, Flint). In other places, population loss and disinvestment were concentrated in some neighborhoods, while other areas continued to grow (Chicago, Philadelphia, New York). In the 1990s, it was common to see a distribution of regional population in a doughnut shape around cities, with thriving suburban areas surrounding decaying urban cores.[7] Today, as population loss slows, cities are receiving an influx of younger, highly educated residents, so that downtown growth and continued suburban development now sandwich decaying urban neighborhoods. In development hot spots, problems of urban decay are now being replaced with problems of gentrification. Today, rather than thinking of urban shrinkage as a permanent phenomenon, it is thought that shrinkage is one phase of the urban life cycle that precedes growth.[8]

Cities positioned near the Great Lakes have been particularly affected by vacancy due to regional industrial decline since the 1970s, with 14 of the 20 largest cities experiencing population loss of 15 to 45 percent over 40 years.[9] How this population loss scales with the quantity of vacant land depends on cities' capacity to undertake large-scale demolition efforts—some cities have had more access to resources for demolition than others. Vacant land is not unique to cities that have gone through decades of depopulation, however. Land vacancy exists in a majority of cities throughout the US,[10] such as cities that have gone through rapid expansion, or cities where geography or policy has allowed sprawl to go unchecked. Aside from house demolition, other conditions that create vacant land include soil contamination, undevelopable slopes, and oddly shaped parcels left by highways and urban sprawl. Finding productive ways to reuse vacant land is of interest to a variety of countries in Europe and Asia, where slower population and economic growth rates, deindustrialization, suburbanization, and globalization have contributed to population loss in cities. As in parts of the US, these conditions abroad have created urban areas that are contending with environmental quality problems, outdated infrastructure, and land vacancy.[11]

Development of small residential parcels during periods of growth, followed by widespread property abandonment, foreclosure, and demolition of vacant structures during industrial decline, has resulted in hundreds or thousands of vacant parcels per city in the Midwest and northeast regions (figure 1-1[12]). Vacancy can occur as large parcels that often bear the contamination of past industrial use, but urban vacant land more commonly takes the form of small residential or commercial parcels that dot street corners and are sandwiched between homes. Due to the piecemeal nature of abandonment and demolition, vacant lots are usually unconnected from one another except in neighborhoods that have had very high rates of population loss (for example, in Cleveland, 85 percent of vacant land exists as three or fewer contiguous parcels, and more than 96 percent of vacant land aggregates are smaller than 0.2 hectares in size). The separation of vacant lots in space and in time—in addition to varied land use histories, sheer number, and the limited resources of shrinking cities—have made it difficult to put vacant lots into productive use.

With population and/or economic stability returning to manufacturing cities, planning for growth has taken on a tone of increased urgency and realism. Smaller, single-company manufacturing cities, such as Flint, Michigan, and Youngstown, Ohio, are planning to shrink urban infrastructure to match projections that population will remain smaller in the long run. Most larger cities shy away from shrinkage as an overt strategy, however, viewing it as being unflattering or pessimistic. These cities are cautiously envisioning what vibrant futures might look like.

In particular, shrinking cities that are situated near abundant freshwater are

Figure 1-1. Like many post-industrial cities that have had significant population loss over the past several decades, the three Vacant to Vibrant cities in this book—Cleveland, Ohio; Buffalo, New York; and Gary, Indiana—have an abundance of urban vacant land. Data sources: NEOCAN-DO and City of Cleveland, Cities of Buffalo and Gary, Esri.

poised for future growth. There is renewed interest in restoring the rivers and lakes that once made eastern cities attractive to manufacturing, while water scarcity predictions for the Southwest and western US have underscored the potential of abundant clean water for future economic growth. These cities are rediscovering clean water as an asset. On shore, nostalgia for earlier times has also rekindled a longing to reclaim "forest cities," a nickname that several cities in North America (Cleveland, Ohio; Rockford, Illinois; London, Ontario, Canada; Portland, Maine; and Middletown, Connecticut) once shared. Environmental compliance issues and climate uncertainty are spurring planning that views water and trees through the lens of climate resilience.

Although[13] generally considered "blight," high rates of urban land vacancy in US post-industrial cities present an opportunity for new, climate-smart patterns of urban redevelopment. On the flip side of manufacturing loss is an opportunity for post-industrial cities to reinvent themselves as vibrant urban areas, where clean, green space serves the economy, residents, and the environment.

Vacant Land as Urban Green Space

In this time of abundant vacant land, “legacy” cities have a window of opportunity to shift away from previous patterns of development by intentionally planning for vacant parcels that will not be rebuilt. Instead, they can re-create themselves as greener cities that are more resilient to future threats by planning for urban green space that is more densely and equitably distributed. By learning from cities that have grown too quickly or densely, they can avoid future costs and problems associated with trying to retrofit green space into densely populated areas.

Managing vacant parcels is often seen as a temporary problem—when there is demand for property for tax-generating land uses again, planners will no longer be asking what vacant parcels are good for. The larger point of vacant land management goes beyond finding interim uses for parcels until they can be redeveloped; it extends to helping determine the best long-term use for parcels within a vibrant city from among a wide array of possibilities. This includes developing criteria for how parcels should be redeveloped or whether they should be redeveloped at all. By describing the full suite of benefits that urban green space provides, including ecological and social benefits, and the monetary value of those benefits, urban greening practitioners can incorporate informed decision making into the planning process for redevelopment. Good policy will be crucial to ensure that adequate green space is preserved for neighborhoods as parcels are acquired and developed one at a time, all over the city, across decades.

While green infrastructure has been embraced in regions such as the Pacific Northwest, manufacturing cities tend to prefer the certainty of traditional engineering solutions. Extensive greening in the urban core also conflicts with the original development patterns of these cities—modest houses in densely packed neighborhoods that did not contain much urban green space. However, abundant vacant land resources and philanthropic interest in green jobs are pushing blue-collar urban areas to explore the potential in green infrastructure.

The Slavic Village neighborhood in Cleveland is a good illustration of development patterns that persisted in industrial cities into the 1950s. Narrow 40- by 100-foot parcels were built up into two- and three-story colonial houses that stretched from driveway to driveway. Detached garages, and sometimes another small house to hold family from the old country (the “mother-in-law suite”), filled the rear of the parcel. Most trees were cleared. Today approximately one-quarter of the parcels in Slavic Village are vacant, and many houses have been abandoned and condemned, awaiting conversion to vacant land through demolition.

Yet many city officials and residents, in Cleveland and elsewhere, still cling to midcentury images of crowded parcels, filled with impervious surfaces that we now know contribute to sewer flash floods that lead to overflows, as a badge of their cities' heyday. Even with clear evidence that modern development patterns should change, they continue to assume that their cities will again be healthy when every parcel is built back up to its original glory.

This idea may not be stated explicitly but can be perceived between the lines in plans that fail to preserve some vacant parcels as permanent urban green space. Many cities largely lack regulations that force the preservation or creation of urban green space, particularly in densely packed or quickly growing neighborhoods, despite a current window of opportunity to envision neighborhoods that are more equitable, walkable, and climate resilient. Many of these same cities do promote green reuse of vacant lots as a temporary holding strategy, however, and pattern books containing recipes for temporary vacant lot reuse strategies are common.[13] In its guidebook on this topic, "Temporary Urbanism: Alternative Approaches to Vacant Land," the US Department of Housing and Urban Development discusses vacant land use primarily as a way to attract investors and reiterates a common concern about vacant land projects:

> In places where temporary interventions have successfully empowered marginalized individuals and turned urban blight into a neighborhood asset, any attempt by a landowner or government authorities to reassert control over the site will likely be met with fierce resistance. . . . The risk of negative press or legal complications from such events may discourage developers from permitting temporary uses in the first place.[14]

The development of land banks has greatly improved the ability to access and aggregate abandoned parcels. A limitation of land banks is that many are only temporary holders of vacant land, by design. Both Genesee County Land Bank (Flint) and Cuyahoga Land Bank (Cleveland) hold parcels over a short period of time, either to rehab the houses and sell them, or to demolish them and pass the vacant land on to other, longer-term holding entities. In many cities that are hungry to grow their tax base, preservation of vacant parcels takes a back seat to development in neighborhoods with market demand.

But there is growing recognition of the potential held within vacant properties by some entities. Park districts are seizing the opportunity to grow their land holdings by purchasing vacant land that connects to parks, reserves, or other urban green space. In Ohio, state funding is available for that purpose (Clean Ohio Fund). Sewer authorities, under consent decree to manage stormwater and observing growing evidence of the effectiveness of green stormwater infrastructure, are purchasing vacant parcels to manage stormwater and provide access points for underground pipes.

Proposals to set aside vacant parcels for permanent preservation as urban green space are starting to appear in long-term city plans. Chicago's CitySpace Plan was among the first of these, created to raise Chicago's rank among similarly sized cities in the amount of urban green space per capita (4.13 acres per 1,000 residents, 18th of 20 in 1998).[15] As of 2012, the proposals and rationale outlined in CitySpace had sparked the preservation of an additional 1,344 acres of green space.

In Pennsylvania, Pittsburgh's 12-part, 25-year plan has an open space component, OpenSpacePGH, that details guidelines for land use and infrastructure decisions that affect the city's 30,000 vacant, distressed, and undeveloped properties.[16] The plan categorizes "opportunity lands" by 16 types of reuse potential based on parcel and surrounding characteristics. In addition, OpenSpacePGH identifies lack of adequate green space as a growing threat in neighborhoods with high market demand.

Farther east, Baltimore's Green Network Plan, in draft form in 2018, proposes to use vacant parcels to grow a system of connecting recreational spaces, trails, and urban gardens.[17] Also up for public comment in 2018 is the city of Gary's comprehensive city plan update, which proposes using vacant lots as green stormwater infrastructure to improve the quality of rivers and beaches.[18]

Stormwater Management in Cities with Aging Infrastructure

Loss of population in post-industrial cities has also created problems for aging urban infrastructure. Roads, utilities, and sewer systems all contend with, and sometimes compete for, shrinking revenue from tax- and ratepayers. Broken pipes, antiquated technology, and changes in climate patterns are creating demand for sewer updates to decrease the frequency of pollution discharges into waterways. To acknowledge the enormous cost of updating sewer systems, and to try to increase the benefits of these investments for ratepayers, green stormwater infrastructure is increasingly being considered as part of a suite of sewer system updates to manage rain and snow melt closer to where it originates.

Stormwater runoff from impervious surfaces is a main source of non-point pollution that negatively affects water quality in many US municipalities. Combined with other sources of water pollution from urban areas, including wastewater treatment plant bypasses and combined sewer overflows, these sources transmit more than 850 billion gallons of untreated water annually into waterways in the Great Lakes and northeast regions of the US, comprising 4 percent of all municipal water discharges. Urban stormwater runoff from impervious surfaces makes up another

10,000 billion gallons, or 45 percent of all municipal water discharges. (For comparison, treated wastewater equals 11,400 billion gallons, or 51 percent of municipal discharges.)[19]

Combined sewer systems[20] are present in 860 US municipalities that experienced major growth during the late 19th century,[21] when such systems were a major technological advancement against epidemics such as cholera.[22]

Regulatory Action as a Driver of Green Infrastructure

In recent years, regulatory compliance has become a growing driver of investment in green stormwater infrastructure. The US Environmental Protection Agency (USEPA) has been taking enforcement action on municipal sewer systems to improve water quality and reduce the quantity of pollution discharges into lakes, rivers, and streams since the late 1970s, ramping up in the 2000s. Enforcement action can take the form of consent decrees or other punitive measures to compel municipal sewer authorities to create long-term control plans to mitigate water pollution. Since 2009, on the recommendation of the International Joint Commission of Canada and the US, these agreements have increasingly encouraged the use of green stormwater control measures, including green roofs, rain gardens, permeable pavement, and vacant land improvements.[23]

Specific to the Great Lakes watershed are designations of Areas of Concern by the US–Canada Great Lakes Water Quality Agreement, identifying severely degraded geographic areas that negatively influence regional water quality. Forced accountability to the Clean Water Act of 1972 has pushed cities near Areas of Concern and elsewhere in the US to reevaluate their stormwater infrastructure and begin billions of dollars worth of upgrades, retrofits, and new facilities. Several cities have turned to construction of massive storage tunnels—up to 32 feet in diameter and miles long, drilled into bedrock at depths of 200 feet or more—that are designed to hold peak flow until volume can be managed by water treatment facilities. Storage tunnels of this type have been constructed in Cleveland, Detroit, Chicago, Fort Wayne, and Toledo.

Many of these cities are also exploring the use of green stormwater infrastructure to reduce the number or size of gray infrastructure projects. Green infrastructure makes use of natural systems, or engineered systems that mimic natural processes, to manage stormwater, promoting local infiltration and using plants and soil to clean, evapotranspire, or reduce water velocity and erosion.[24] (Throughout the book, "green infrastructure" is used to describe green space that has been designed to perform a specific ecological service—usually, stormwater management—while "urban green space" is used more generally to describe spaces that deliver a variety of services.) As evidence builds that green infrastructure can effectively manage stormwater runoff and confer other ecosystem benefits, long-term control plans for sewage and stormwater are increasingly including green infrastructure as part of the system updates required for compliance.

Large versus Small Green Infrastructure

The format of green stormwater infrastructure can be divided into two types: large projects that collect stormwater from many parcels and route it to a single stormwater management feature, and smaller, distributed projects that sit higher in the watershed and collect stormwater closer to where it falls. As an example of a large stormwater project, the Northeast Ohio Regional Sewer District, which includes the city of Cleveland, is constructing green stormwater infrastructure on 39 acres (including 31 acres of vacant land) to mitigate at least 500 million gallons (out of a goal of 4 billion gallons) of combined sewer overflow volume annually.[25] Their approach centers on large projects that require the aggregation of numerous vacant parcels, with the goal of improving the overall health, welfare, and socioeconomic conditions of neighborhoods by providing benefits above stormwater capture, such as improved air quality, recreational space, and removal of blighted properties.[26] In Milwaukee, the Menomonee River stormwater park incorporates pedestrian trails and waterfront access into a brownfield redevelopment site that manages stormwater from a large basin up to the level of a 100-year storm event. In Detroit, transformation of entire neighborhoods of vacant land into lakes for stormwater management has been proposed.[27]

In contrast to the large installations, a distributed stormwater management approach makes use of the most common type of urban vacant parcel—small, unconnected, formerly residential or commercial lots. While residential parcels are least likely to require expensive remediation, acquiring and aggregating many parcels can be a logistical challenge. A distributed stormwater management approach manages runoff closer to where it originates, however, so it does not require sewer separation, discharge, or associated costly infrastructure.

An advantage of distributed green infrastructure is that numerous smaller projects offer a higher level of engagement within neighborhoods, providing more interaction with residents. Research from cities that have excess land vacancy due to population loss or urban sprawl shows that urban greening projects that are tailored for stormwater management can also strengthen neighborhoods. In Philadelphia, vacant land that has been cleaned of trash and debris, greened with grass and trees, and managed as part of the Philadelphia LandCare program has lowered violent crime[28] and increased property values.[29] Additionally, green stormwater infrastructure in Philadelphia yielded reductions in public safety incidents within a half-mile radius.[30] In Baltimore and Pittsburgh, crime rates are lower in neighborhoods with more tree canopy.[31]

Challenges to Building Green Infrastructure on Vacant Lots

Despite growing evidence of the myriad benefits of green infrastructure networks, many challenges remain. A majority of vacant land reuse projects are single projects that are planned from the parcel level up. Typically, they start with a neighborhood eyesore or problem; a proposal is created for a project that will address the problem; funding is secured; and the project is built. Even for stormwater control, it is not uncommon to see green infrastructure projects planned in this way, where a parcel's position in the watershed, soil permeability, slope, and other physical attributes that affect stormwater management are not considered until later stages. A risk of this approach is that implementation costs can be out of scale with the resulting level of stormwater control.

This normal mode of operations hinders the ability to scale green stormwater projects up to the level of urban infrastructure, where cost efficiency and performance metrics guide investment decisions. A roadblock to changing the way projects are planned is difficulty in acquiring the necessary data; additionally, spatial tools, where they exist, often do not support top-down decision making. Sources for data on ownership, land use history, and physical attributes are typically scattered across multiple entities. Data access can be especially difficult for practitioners outside of local government, because some types of data, such as detailed sewer information, are considered to be sensitive. Scaling up green stormwater infrastructure will require detailed information about social and environmental attributes that can help decision makers work from all available sites down to specific parcels with desired features.

As an example of the potential impact that tools can have, urban forestry has demonstrated success in enlisting cities to set and achieve large-scale tree canopy goals via a suite of free and paid toolkits, software, and guidance documentation aimed at decision makers. These products have helped dozens of cities throughout the US understand the value of their urban canopy and create plans for growing it for the benefit of humans and the environment.[32] The demonstrated value of urban tree canopy has led to recent recommendations that tree planting and maintenance costs become part of urban health budgets, because of clear evidence that they improve public health outcomes.[33] Although these tools stop short of including parcel-level information that is specific to vacant lots, such as ownership and land use history, they make clear suggestions for where urban forest canopy is absent but possible, and they show the societal impacts that can be delivered through placement of individual trees.

Difficulty in accessing data that are necessary for informed land use decisions highlights a broader challenge to scaling up green infrastructure on vacant lots, which is that the entities who are accountable for stormwater control and vacant land disposition can be fractured across separate agencies, making coordination and cost-sharing difficult. Other systems-level challenges for green stormwater infrastructure (and other urban greening) on vacant lots include lack of a workforce that is knowledgeable about nontraditional landscaping practices as well as technical components, such as stormwater management systems. In addition, materials are specialized. For example, native prairie plants are common to stormwater best management practices because they are low-maintenance, provide habitat, and can do well with fluctuations in soil moisture. However, native plants must be obtained from select growers, and they are limited in both quantity and seasonal availability, which makes them expensive and hard to find.

Vacant to Vibrant set out to address these systemic challenges to scaling up urban green infrastructure. Although one project cannot solve all problems for every city, our hope was that findings from our interdisciplinary team of practitioners, working through parallel planning, implementation, and maintenance processes for urban greening/vacant land use projects in three cities, could move the needle on tackling existing barriers. While the confluence of urban land vacancy, stormwater management, and neighborhood destabilization is common to many post-industrial cities, lessons learned from Vacant to Vibrant can apply to cities throughout the US that are growing their urban green space in response to demographic, economic, and climate changes. Where our lessons do not produce solutions, we hope that they provide points that advance the conversation about current barriers and inform the next iteration of innovative urban greening practices.