BRIDGING THE GAP BETWEEN DATA AND COMMUNITIES: A MODEL FOR VACANT LAND REDEVELOPMENT IN CLEVELAND

A Research Paper

Presented to the Graduate School of Cornell University

In Partial Fulfillment of the Requirements for the Degree of

Master of Regional Planning

by

Hanyu Zeng

May 2025

CORNELL UNIVERSITY
COLLEGE OF ARCHITECTURE, ART, AND PLANNING
DEPARTMENT OF CITY AND REGIONAL PLANNING

APPROVAL OF RESEARCH PAPER

Name of Candidate: Hanyu (First Name) Zeng (Middle Name/Initial) (Family/Last Name)

Graduate Field: CITY AND REGIONAL PLANNING

Degree: MASTER OF REGIONAL PLANNING (M.R.P.)

Title: Bridging the Gap Between Data And Communities: A Model for Vacant Land Redevelopment in Cleveland

COMMITTEE SIGNATURES:

Chairperson: Mitch Glass Date: May 12, 2025

Member: Date: May 12, 2025

Member: Date:

Member: Date:

Member: Date:

LICENSE TO USE COPYRIGHTED MATERIAL

I do hereby give license to Cornell University and all of its faculty and staff to use the above-mentioned copyrighted material in any manner consonant with, or pursuant to, the scholarly purposes of Cornell University, including lending such materials to students or others through its library services or through interlibrary services or through interlibrary loan, and delivering copies to sponsors of my research, but excluding any commercial us of such material. This license shall remain valid throughout the full duration of my copyright.

hanyu zeng

Student

ABSTRACT

In Cleveland, Ohio, the challenges of vacant land redevelopment are becoming increasingly urgent, with numerous barriers hindering the process. In response, a GIS-based methodology was developed to prioritize vacant land uses, integrating data-driven analysis with ground-truthing to achieve consensus on optimal land utilization. This model enhances land use efficiency by prioritizing city initiatives, promoting more compact and mixed land uses, and incorporating insights from both experts and residents. This paper provides a detailed overview of the model's background and implementation process, while also discussing key barriers to its effective application and promotion. One of the key takeaways was the need for a comprehensive and equitable approach to revitalizing underutilized vacant parcels—one that integrates GIS-based suitability analysis with ground-truthing.

In this research paper, I outline an integrated methodology combining data-driven GIS analysis and ground-truthing that can prioritize land use recommendations in underutilized areas. Ground-truthing serves as a critical layer of information to inform GIS-based mapping approach to give a much finer grained level of detail in terms of vacant land's potentials and constraints. This land use repurposing model fosters optimized, iterative land use proposals, ensuring that recommendations are both technically feasible and aligned with community needs and aspirations (Cleveland Planning Commission, 2024). While it is not a perfect solution, it provides a bridge between longstanding policy and data driven efforts at vacant land reuse to potentially valuable pathway for refining vacant land redevelopment strategies and enhancing revitalization efforts in the future.

BIOGRAPHICAL SKETCH

Hanyu Zeng is a planning professional with a strong commitment to social issues and equity. She is passionate about creating livable, healthy, and just communities. Her interests lie in land-use planning, community planning, and transportation planning.

Hanyu Zeng is receiving her Master's degree in Regional Planning from Cornell University in 2025. She also holds a Bachelor's degree from Xi'an Jiaotong-Liverpool University (2023), with a major in Urban Planning & Design.

ACKNOWLEDGMENTS

I am deeply thankful to my academic advisors, Mitch J. Glass, Mildred E. Warner, and Stephan J. Schmidt, whose guidance and encouragement have been instrumental in developing this paper and helping my personal growth.

I am incredibly grateful for my internship experience in Cleveland, Ohio. Thanks to Cornell alumnus Joe Keithley, whose generous funding supported my fellowship with the Western Reserve Land Conservancy, and to my supervisor, Tim Dehm—another Cornell alumnus—who provided invaluable guidance throughout my internship. I also want to extend my appreciation to the Cleveland Planning Commission for initiating the program, as well as to Planning Manager Matt Moss, and the dedicated staffs Samia Azizuddin and Madison Newingham. I am particularly grateful to Samia Azizuddin's significant contributions to the GIS-based technical framework that laid the foundation for this GIS/ground-truthing model. During my internship, I built upon the preliminary model developed within the team and, together with Samia Azizuddin, revisited and expanded the data-driven analyses. I thoroughly documented the planning process and conducted further research, which ultimately laid the foundation for this paper.

TABLE OF CONTENTS

LIST OF PICTURES

INTRODUCTION

Overview

Cleveland is representative of a typical Rust Belt city, characterized by abundant underutilized parcels and neighborhood blight (Hollstein, 2019). Historically, from the late 19th century through World War II, Cleveland thrived as a pivotal hub for transportation, commerce, and industry, with significant contributions from oil refining, steel production, and automotive manufacturing sectors. During this period, the city's prosperity was evident in the fancy mansions along Euclid Avenue and the establishment of world-class cultural institutions (Hollstein, 2019), with its residents peaking to nearly 1 million in 1950s (*Visual Cleveland | Decennial Census Data -- Cleveland Population Change, 1800-2020*, n.d.). However, Cleveland's economic vitality rapidly declined after World War II. As Cleveland transitioned from its industrial golden days, it was left with a legacy of abandoned industries and disadvantaged people who were unable to flee, creating a landscape marked by extensive vacant lands, especially numerous brownfields, social instability, and blight. As of 2020, Cleveland's population had shrunk to 372,624, representing just 40% of its peak size, after nearly a century of decline (*Visual Cleveland | Decennial Census Data -- Cleveland Population Change, 1800-2020*, n.d.).

In 1969, Cleveland stood at its lowest ebb, as the Cuyahoga River, choked with industrial waste, caught fire time and again (Kovach, n.d.). The flames upon the river stirred not only the air but also the conscience of the city and the nation. It pushed the passage of the National Environmental Policy Act in 1970. The Northeast Ohio Regional Sewer District invested over $3.5 billion in restoring the Cuyahoga River as part of the Clean Water Act, and the city has continued to uphold annual waste management programs to keep the river and its surroundings clean. Over the past half-century, much of the downtown area has been rebuilt, with skyscrapers rising into the city's skyline in the 1980s and 1990s (Murray et al., 2021). Brownfield development and urban revitalization emerged as key governmental initiatives after the mid-1900s, forming an integral part of strategies aimed at regenerating urban cores and fostering smart growth (De Sousa, 2005). In the 1980s, under Mayor George V. Voinovich, slum clearance and demolition initiatives paved the way for projects like BP America's headquarters

and the preservation of Playhouse Square. The 1990s saw continued transformation with the $200 million Tower City Center, new housing in blighted neighborhoods, and commercial hubs like Church Square. Investments in sports and culture, including the Gateway Complex and the planned Rock and Roll Hall of Fame, underscored a broader strategy to regenerate the urban core and make Cleveland a "Comeback City" (*CITY PLANNING | Encyclopedia of Cleveland History | Case Western Reserve University*, 2019). Most recently, Public Square was reconceived as a world class park alongside the construction of the new 36-story Sherwin Williams world headquarters tower. Even as Cleveland has experienced a dramatic decline, citizens, business leaders, and elected officials have been and are still working together to curb the blight in Cleveland.

In some areas of Cleveland, urban decline appears to be slowing or even reversing. Some Special Planning Areas (SPAs), such as Downtown, Ohio City, Edgewater, and Old Brooklyn (Figure 1 in green), experienced significant population growth and housing expansion between 2010 and 2020. Notably, Downtown saw an 80% increase in housing units and population growth of over 40%. Additionally, two primarily residential areas—Ohio City, located west of Downtown, and University Circle, the arts district on the East Side—also witnessed substantial growth in both housing and population (*Census 2020, n.d.*). That said, it is evident that East Cleveland is significantly more disadvantaged, as most SPAs experiencing both housing and population decline (in pink) are located there. Some SPAs exhibit an adverse trend, with a slight decrease in population alongside modest housing growth. Meanwhile, SPAs where housing construction and population growth are misaligned (in yellow) are primarily concentrated on the west side, an area characterized by higher-quality single-family housing (*Census 2020, n.d.*).

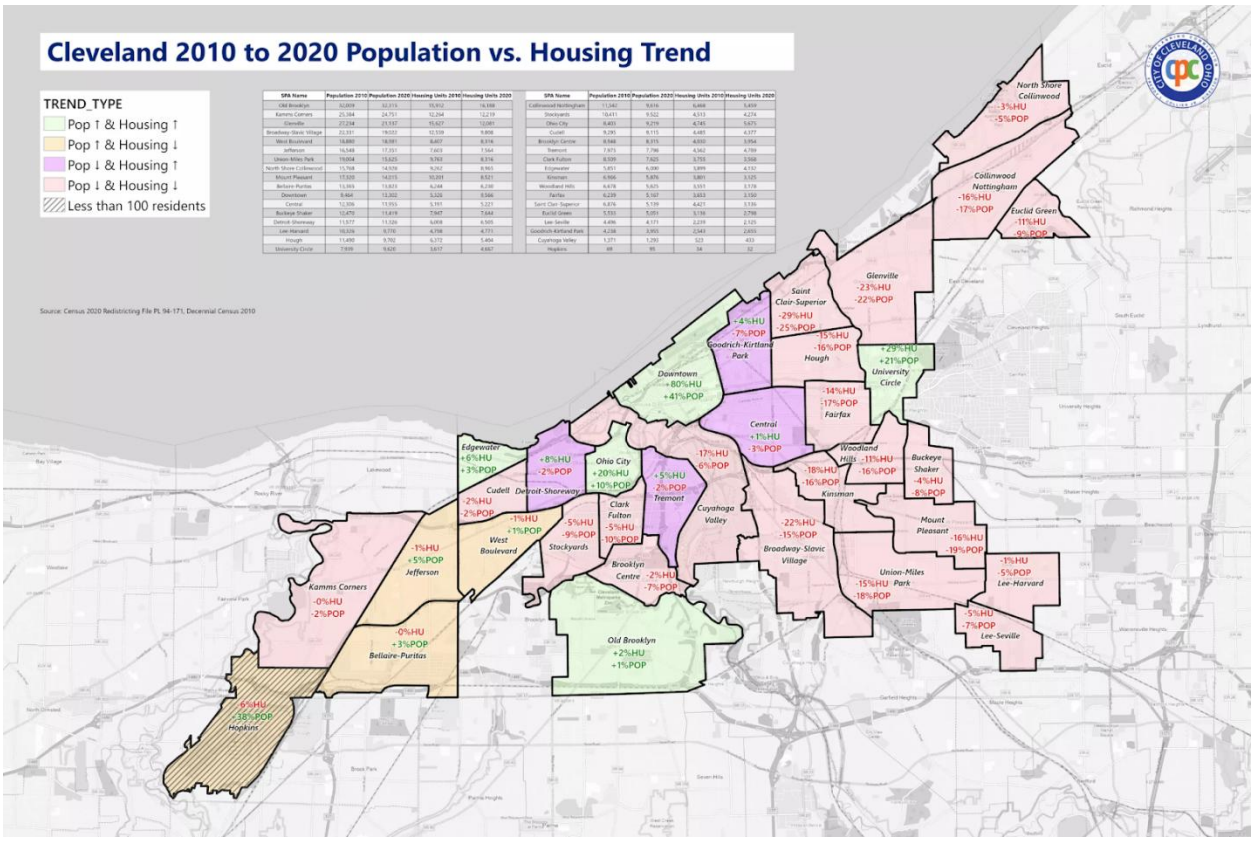


Figure 1 Census 2020 (n.d.), retrieved from the Cleveland Planning Commission. Data map showing the five Cleveland neighborhoods (in green) with optimistic Census trends: where people were increased, and housing was added

Despite these success stories, core urban issues remain in the surrounding neighborhoods to the east and south; the downtown transformation has not yet fundamentally changed the city's declining reality at the neighborhood and community scale. Cleveland's decline persisted through the late 20th century and worsened with the strike of the Great Recession. Between 2007 and 2015, over a quarter of the city's properties faced foreclosure. Communities struggled with a chain reaction of challenges, including deteriorating buildings, lead contamination, and speculative investors purchasing homes online in quantity (lincoln-superuser, 2021).

The Role of Land Banks

In Cleveland's fight against this ongoing blight, land banks have played a crucial role in the attempt to make change. The foreclosure crisis has had a profound impact on disadvantaged

neighborhoods in Cleveland, particularly those with predominantly black residents. The collapse of the housing market led to widespread property abandonment, prompting the local land bank to intervene. Through a revised administrative tax foreclosure process, vacant and derelict properties have been reclaimed to mitigate urban decay (Progress, 2021). Currently, out of Cleveland's 167,000 land parcels, approximately 33,000 remain vacant, with 18,000 of them under the ownership and management of the Cleveland Land Bank (Kowalski, 2024). These vacant lots are more than just a visual blight on local neighborhoods. They contribute to issues such as illegal dumping and crime while increasing the city's financial burden due to maintenance (Kowalski, 2024). In Cleveland as in all Rust Belt cities, the presence of brownfields and other polluted areas creates gaps in the urban fabric and poses challenges for redevelopment or reuse because they are complicated by hazardous substances, pollutants, or contaminants (Wallerstein, n.d.).

In response to the blight of post-industrial vacant land conditions, multiple stakeholders in Cleveland have been gathering and analyzing vacant parcel data for the past several decades, including brownfields. In recent years, the City of Cleveland collaborated with entities such as the Western Reserve Land Conservancy (WRLC) to survey, assess, and analyze close to 163,000 parcels (*City of Cleveland Property Inventory - 2023*, 2023). With federal dollars from the American Rescue Plan Act (ARPA), the city utilizes the data to enhance existing initiatives and develop programs aimed at supporting homeowners, safeguarding renters, focusing on reforestation projects, and enhancing lead awareness, mitigation, and hazard reduction efforts. The property inventory result also provides a statistical analysis of property ratings and locations, and they highlight features in property data by ward and neighborhood (*City of Cleveland Property Inventory - 2023*, 2023). These documents and analyses provide a solid foundation for the redevelopment efforts of Cleveland's vacant lands, especially brownfields.

Zoning

Redevelopment of vacant land parcels has been historically challenging and restrictive due to the exclusionary nature of traditional zoning, which restricts innovative land use strategies. Racially

discriminatory practices like redlining, which have concentrated disinvested neighborhoods predominantly in East Side Cleveland, also have posed additional challenges for redevelopment (*Lasting Impact of Cleveland's "Redlined" Neighborhoods*, 2020.). These outdated zoning practices often fail to integrate community input into decision-making, resulting in development proposals that are not achievable and that do not fully align with local needs.

However, Cleveland presents an opportunity for zoning reform through approaches like form-based codes, which emphasize flexibility and design over rigid zoning for land development. By leveraging large datasets, GIS analysis, and ground-truthing, planners can make more informed zoning reform decisions that reflect on-the-ground realities. City planners and policymakers have recently taken on the role of visionaries, breaking away from conventional constraints and introducing creative approaches such as Transit-Oriented Development (TOD), the 15-Minute City Index, and nature-based solutions (Cleveland Planning Commission, 2024). Combining expert consultation with resident input, the Cleveland Planning Commission (2024) hopes to harness these collective efforts to counteract the limitations of outdated zoning practices, further addressing the vacant land inventory burden for the land bank and promoting prioritized vacant land redevelopment.

Summer Internship (2024)

In the summer of 2024, I interned with the Western Reserve Land Conservancy (WRLC) and helped develop and implement a GIS-based mapping model with the Cleveland Planning Commission and other community development corporations (CDCs) like Slavic Village Development and Burten, Bell, Carr. My internship experience provided me with firsthand exposure to the complexities of urban revitalization and procedural land-use planning. Through participation in Planning Commission meetings and discussions, I observed the intricate balance between policy, community needs, environmental constraints, and economic realities. These meetings highlighted both challenges and opportunities in reshaping Cleveland's urban landscape. One of the key takeaways was the need for a comprehensive and equitable approach to revitalizing underutilized vacant parcels—one that integrates GIS-based suitability analysis with ground-truthing.

Through this streamlined land use repurposing strategy, urban planners can ensure that the proposed land uses are not only technically feasible but also resonate with the local community's visions. This novel methodology enables a balanced integration of professional expertise and local insights, fostering a consensus-based planning approach. It combines city initiatives such as Transit-Oriented Development (TOD), the 15-Minute City Index, and nature-based solutions, along with input from neighborhood planners and residents' ground-truthing, to ensure a more holistic and adaptable urban redevelopment process. Through such synergistic practices, it is possible to propose equitable and sustainable land-use solutions that are informed both by analyzed data as well as insights from the professional and local level, thereby avoiding the pitfalls of relying solely on either technological solutions or unstructured community inputs (Cleveland Planning Commission, 2024).

Before I stepped into this project, the land use repurposing model had already benefited from a strong foundation within the community. The neighborhood was served by existing RTA transit stations, and the local CDCs—such as Slavic Village Development and Burten, Bell, Carr—had built trusted, effective communication channels with residents over time. Additionally, the Western Reserve Land Conservancy had previously conducted parcel-level surveys of vacant land, while the Cleveland Planning Commission had assembled spatial datasets and conducted preliminary GIS analyses that could be expanded upon. Importantly, there was a shared recognition among the City, CDCs, and residents that revitalization efforts must prioritize affordable housing while addressing residents' more immediate, people-centered concerns—such as employment, safety, and sanitation. The long-term objective was not gentrification, but to bring vitality back to the neighborhood in a way that reflected the community's values. In this context, the GIS-ground-truthing model served as a critical bridge: a way to translate technical planning tools into a participatory process that could engage residents meaningfully. While the model itself cannot realize the community's vision overnight, it provides a scalable framework for continuous community-centered planning and action.

In this research paper, I outline an integrated methodology combining data-driven GIS analysis and ground-truthing that can prioritize land use recommendations in underutilized areas. Ground-truthing serves as a critical layer of information to inform the GIS-based mapping approach to give a much finer grained level of detail in the terms of vacant land's potentials and constraint.

This land use repurposing model fosters optimized, iterative land use proposals, ensuring that recommendations are both technically feasible and aligned with community needs and aspirations (Cleveland Planning Commission, 2024). While it is not a perfect solution, it provides a valuable pathway for refining vacant land redevelopment strategies and enhancing revitalization efforts. Further reflections on the model and recommendations are discussed in the critical reflections section. For example, the model faces limitations in the conflicting interests of stakeholders, the uncertainty of future predictions, the applicability of data-driven mapping, and its broad-scale implementation.

Paper Structure

This **Introduction** provides a background on the historical trajectory of Cleveland, deindustrialization, population loss, vacant land distribution, and past and current strategies around land revitalization.

The **Literature Review** explores the role of GIS applications in land use planning, emphasizing how spatial analysis tools contribute to decision-making. Community-based planning and ground-truthing is then introduced, highlighting the importance of resident participation in shaping land use policies. By integrating GIS analysis with inclusive engagement processes like ground-truthing, the model addresses the technical challenges of land reuse, but also ensures that redevelopment reflects the lived experiences and needs of its residents.

The **Application** section how Cleveland is applying GIS-based planning models to address urban vacancy, promote sustainable land use, and support inclusive redevelopment. The chapter delves into city-wide initiatives, such as Transit-Oriented Development and the 15-minute city concept, evaluating how these frameworks enhance accessibility and livability. The city is strongly behind these efforts and believes in them, designating staff and resources to undertake research and pilot projects. Finally, Nature-Based Solutions are discussed as a means of integrating sustainability into land use recommendations. Zoning reform, Transit-Oriented Development (TOD), the 15-minute city vision, and Nature-Based Solutions collectively offer a data-informed planning model to prioritize vacant land reuse. This approach facilitates the use of comprehensive and

fine-grained spatial data to support more informed, evidence-based, and efficient decision-making in land use planning.

The **Methodology** section outlines the approach adopted in this research. It introduces the pilot study area Buckeye/Woodhill, including its development trajectory, demographic analysis, community organizations, and neighborhood projects. Then it details the data collection and analytical process, including spatial data collection, spatial analysis, stakeholder engagement, and field verification. The main purpose of this section is to technically introduce each step of the methodology, while linking it back to the previously constructed theoretical framework. It provides a detailed explanation of the model's rationale and offers technical guidance, aiming to provide professionals who wish to replicate or improve the model with a clear reference.

The **GIS/Ground-truthing Process** chapter presents the pilot case study of Buckeye/Woodhill. This section presents how every vacant parcel in Buckeye/Woodhill was identified and categorized using GIS and professional and community input within a streamlined process. It also covers the designation of thresholds, mathematical calculations, and spatial methods, with each step thoroughly explained and presented in detail. In addition to the data-driven mapping process step by step, the chapter also illustrates how spatial analytics, expert insights, and resident-led verification were combined to refine land use proposals. The Slavic Village pilot established a structured ground-truthing framework. The process empowered residents to validate or challenge land use recommendations, and their input was reviewed and selectively incorporated into finalized proposals. This model was later adapted for Buckeye-Woodhill, where the planning process was optimized based on lessons learned from Slavic Village.

The **Critical Reflections** chapter provides a critical assessment of the application process and findings. It explores the strengths and limitations of methodology and elucidates how the interplay of dream, data, partnership, and power shapes and promotes vision change. It shows that forecasting bias, administrative constraints, policy limitations, and the complexities of engaging residents in the planning process can possibly contribute to the model's practical limitations.

LITERATURE REVIEW

GIS Suitability Analysis in Land Use Planning

As Cleveland explores new regulatory frameworks, Geographic Information Systems (GIS) play a crucial role in analyzing land-use potential and guiding redevelopment efforts. A Geographic Information System (GIS) is a system of hardware, software and processes that facilitates the administration, manipulation, analysis, modelling, representation and visualization of georeferenced data to tackle the organization and stewardship of resources (Escobar et al., 2008). The data-driven overlay procedures are crucial in various GIS applications (O'Sullivan, c2003). These techniques are leading the innovations in land-use suitability analysis. They include multicriteria decision analysis (MCDA), artificial intelligence methods in geo-computation, visualization methods, and Web-GIS methods (O'Sullivan, c2003; Malczewski, 2004).

GIS has been widely applied in land-use assessment, especially suitability studies. McClintock et al. (2013) utilized GIS analytics and mapping to assess the potential contribution of vacant land to agriculture in Oakland, California, thus identifying the potential sites of production. Based on the parcel conditions, such as parcel size, slope, land use in the land inventory, McClintock et al. (2013) identified the ecological values of the vacant land parcels. In McClintock et al. (2013)'s research, GIS is instrumental in identifying suitable sites for specific land uses, such as urban agriculture. By analyzing multiple land parcel information, GIS helps pinpoint vacant or underutilized land that can be repurposed.

Beyond land use assessment, GIS can serve as a decision-support tool and offer a bottom-up alternative to traditional top-down planning approaches, promoting multi-stakeholder collaborative decision-making (Pearsall et al., 2014). Pearsall et al. (2014) proposed a GIS-based Multi-Objective Land Allocation (MOLA) method to help policy makers determine the prioritized uses of land, including residential, commercial, and green space redevelopment. They can choose the prioritized uses with the help of a Multi-Criteria Evaluations (MCE) decision support tool. However, Pearsall et al. (2014) also highlighted that economic considerations often drive repurposing decisions, as cities prioritize developments that generate tax revenue, such as housing and businesses, over green projects like parks and green spaces.

However, most GIS methods are designed around theories of spatial representation and computation, incorporating firm beliefs in the instrumental rationality that underpins spatial planning processes (Malczewski, 2004). Instrumental rationality makes a positivist hypothesis, assuming spatial reasoning and scientific analysis guides the planning process. It operates on the premise that there is a straightforward correlation between the quality of information and the performance of decision-making derived from that information (Malczewski, 2004). However, this approach overlooks the impacts of social, political, and public participation factors, instead favoring a more technology-driven decision-making model.

Compared to Malczewski (2004), who focuses on the technical aspects, Elwood (2002) critically reveals the intricate ways that GIS influences the way knowledge is created and used in urban planning. Elwood (2002) argues that technological complexity may hinder resident empowerment and contribute to power inequalities. Elwood (2002) studied the needs of the community to access GIS technology and conducted in-depth interviews with the Minneapolis community to understand the GIS dilemma. She proposed that improving the use of GIS in marginalized communities promotes empowerment. She revealed that GIS is not a neutral tool. While it enhanced the legitimacy of the neighborhood as an association, it also altered its practices and objectives. Notably, it fostered a greater dependence on rational planning processes, which may inadvertently create participation barriers for certain residents (Elwood, 2002). Additionally, the emphasis on standardizing information led to a shift in priorities within the organization, giving those with stronger technical skills more voice (Elwood, 2002).

For vacant land projects to foster meaningful participation, they should address the needs of under-resourced groups, such as low-income communities, by creating dedicated spaces for marginalized populations to contribute (Kim et al., 2020). Tailored surveys can also serve as a valuable tool for gathering input from these groups. When individuals from disadvantaged backgrounds participate in deliberative forums, they tend to approach their roles with seriousness, demonstrating a willingness to engage, learn, and discuss (Kim et al., 2020).

Malczewski (2004) also highlights how the role of technology in GIS and urban planning has evolved over time, transitioning from a pure technical tool to an interactive system that actively involves policy makers, planners, and residents in decision-making. During the innovation stage

(1950s–1970s), GIS functioned primarily as a scientific tool for computer-assisted overlay mapping. In the integration stage (1980s), it began incorporating political considerations, utilizing cartographic modeling and Multi-Criteria Decision Analysis (MCDA) to support more complex decision-making. By the proliferation stage (1990s–present), GIS became more user-oriented, adopting participatory and collective design approaches while integrating AI-driven geocomputation, web-based GIS, and interactive visualization. Klosterman (2001) described the 1990s as an era of "collective design" in information technology, where systems were developed to enhance social interaction and promote shared objectives. Within this framework, GIS is being viewed as a collaborative planning tool used in partnership with the public, rather than a tool for top-down plan making. This evolution marks a shift from technical and data-driven planning toward a more inclusive and collaborative decision-making process in urban development.

Ground-Truthing in Community-Based Planning

Community-based planning has gained growing recognition as an essential framework for fostering equity, responsiveness, and legitimacy in urban and regional planning. Unlike traditional top-down approaches that centralize authority and limit public input, community-based planning emphasizes the active involvement of residents and stakeholders throughout the decision-making process. This model seeks to reflect the lived experiences, values, and priorities of diverse communities by integrating their voices into planning outcomes.

In contrast to top-down decision-making, collaborative planning seeks to integrate diverse perspectives into the planning process, ensuring that stakeholders contribute to shaping outcomes. Collaborative or participatory planning involves engaging residents and stakeholders in the planning or decision-making process through various methods such as surveys, online forums, public gatherings, and field visits, with the aim that their involvement will shape the planning outcomes (Faehnle & Tyrväinen, 2013). To effectively implement collaborative planning, meaningful community engagement should establish a two-way conversation that respects a community's history, perceptions, and experiences. Unlike top-down decision-making, participatory planning follows a spectrum, ranging from informing the public to empowering them in decision-making (Fedewa & Severn, 2014). Fedewa & Severn (2014) argued that the

depth of engagement depends on the investment of time and trust-building efforts, with stronger relationships and partnerships leading to more inclusive and impactful planning. By incorporating diverse perspectives through surveys, public meetings, focus groups, workshops, and advisory committees, participatory decision-making, and delegated decisions, planners can gradually promote more responsive and equitable planning processes (Fedewa & Severn, 2014). This progression moves from informing and consulting the public to actively involving and collaborating with them, ultimately leading to shared decision-making and empowerment.

A key tool in participatory and collaborative planning is **ground-truthing**, which has evolved beyond its original use in verifying remote-sensing data. Pickles (1995) reinterpreted ground-truthing as a tool for critical legal analysis and community knowledge and expanded the traditional concept of ground-truthing. This involves geospatial technicians verifying remote-sensing data, by critically introducing an early critique of GIS and its function in corporate and state surveillance and control over society. In Pickles (1995)'s study about critical legal theory, maps were ground-truthed by people of color, relying on critical community knowledge to define boundaries and racial divides. This approach is crucial in assessing the allocation of public facilities and understanding its effects on communities, neighborhoods, and their residents.

Beyond the application in legal and social contexts, ground-truthing has also been widely used in environmental land use analysis. Morckel (2015) conducted a comparative study assessing the perceived attractiveness of community gardens and vacant lots in Columbus, Ohio, utilizing photographic evaluation as a ground-truthing approach. The study incorporated on-site photographic documentation, participant perception surveys, and expert maintenance assessments, offering a multi-dimensional validation of land conditions. Eanes & Ventura (2015) identified and assessed vacant urban land for potential community garden sites in Madison, Wisconsin by combining stakeholder input, expert knowledge, and ground-truthed data. After filtering out unsuitable parcels during the virtual site identification process, 1,330 of the original 3,650 parcels remained (Eanes & Ventura, 2015). In the data verification stage, ground-truthing was conducted to verify the accuracy of remotely sensed or interpreted data. The remaining parcels underwent in-person site visits, where researchers assessed additional suitability factors that could not be evaluated remotely, such as proximity to water sources, transportation accessibility, and land-use conflicts (Eanes & Ventura, 2015). The process later incorporated

stakeholder input to refine and weigh different suitability criteria; several decision models were carried out for a comprehensive suitability analysis (Eanes & Ventura, 2015).

Working together across different sectors depends on an understanding of how people think, act, and take the lead in their communities. By encouraging integrative collaborative learning, stakeholders can develop the capability to think about and deliberate issues systematically (Kim et al., 2020). Residents can produce experience-based knowledge, when integrated into the planning framework, enriches the quality of decision-making (Faehnle & Tyrväinen, 2013). Kim et al. (2020) identified policies and programs designed to address the challenges of vacant land projects, with a particular emphasis on community participation. According to Kim et al. (2020), while high vacancy rates pose significant challenges for cities facing financial and social instability, implementing community engagement strategies can help release the positive potential of vacant land, increase public awareness, and foster a more constructive perception of land use. In this process of idea exchange, participants may uncover possibilities they hadn't initially considered, such as reimagining vacant land not just as a site for future development speculation but as an immediate opportunity to create green spaces that bring tangible value to the community, thus shifting perspectives to explore the land's true value.

APPLICATIONS OF GIS-BASED MODELING CLEVELAND

Building on the discussion of reconciling GIS analysis with on-the-ground conditions, it is crucial to explore how these tools address both the existing challenges and opportunities in Cleveland's planning landscape. Two major concerns—vacant land and zoning reform—highlight the pressing need for more strategic and data-driven planning approaches. With a substantial inventory of vacant properties, the city has to repurpose underutilized spaces and reduce the financial and environmental burden of vacancy in the land bank. Simultaneously, zoning reform offers a possibility to reimagine land use more systematically, innovatively, and inclusively, ensuring that redevelopment efforts align with evolving resident needs. GIS and ground-truthing play a pivotal role in identifying parcels suitable for redevelopment.

Beyond the current land use challenges, GIS informs broader city initiatives aimed at shaping a more livable and sustainable Cleveland. From TOD and 15-minute city strategies to Nature-Based Solutions, these planning approaches reflect the City's aspirations for a more compact, sustainable, livable, and equitable urban environment. Translating these visionary goals into actionable planning requires technical tools like GIS, and a nuanced understanding of how they align with professional advice and resident insights through consultation and ground-truthing. This section delves into how GIS-based models are implemented in Cleveland, considering the intersection of data-driven decision-making with the City's policy goals, aspirations, and the implementation challenges.

Land Bank & Vacant Land Redevelopment

Deindustrialization has led to significant demographic and economic shifts in rest belt cities such as Cleveland, resulting in lower urban densities and less intensive land use. Innovative land management strategies have emerged as a response to these challenges, aiming to repurpose vacant properties and mitigate urban shrinkage. Throughout the 20th century, population decline with excessive vacancy was most pronounced in cities across the Northeast and Midwest, a trend that has been far more prominent in the U.S. than in other countries (Mallach,2023). This trend is evidenced by the fact that 49 American Rust Belt cities have lost over 50% of their housing stock since 1970 (Hackworth, 2016). As population and household numbers decline, so does the demand for housing, stores, and workplaces, leading to physical transformations in these cities.

Vacant buildings are often demolished, reshaping the urban landscape and making demolition a widely used policy tool for managing urban shrinkage. Mallach (2023) argued that shrinking cities should recognize that national and regional governments may not intervene to rescue them, requiring them to adopt flexible strategies to manage urban shrinkage. In response to the crises, many cities and counties have established land banks to handle the growing number of vacant properties (Hackworth, 2016). Approximately 200 cities in the U.S. have established community land trusts, which take over vacant, foreclosed properties, maintain and spin off them, and repurpose the parcels for new uses such as affordable housing (Mallach,2023).

The idea of land banks emerged in the 1960s as proposed innovative tools to two contrasting yet interconnected urbanization challenges: the uncontrolled suburban sprawl and the growing abandonment of inner-city (Alexander, 2011). Initially conceived as a tool to manage land more strategically, land banks were envisioned as public entities that could acquire and hold land for future use. Their role became especially significant in addressing the increasing tax-delinquent and abandoned properties. However, they were often left out of the private market due to their low value or legal complications (Alexander, 2011). Over the past forty years, land banking has dealt with widespread property abandonment rather than as a proactive land reserve entity (Alexander, 2011). The focus has largely been on managing delinquent property taxes and reclaiming vacant properties. While in some areas land banks have been used strategically for neighborhood redevelopment, their primary function has been to intervene in market failures (Alexander, 2011).

Cleveland was among the first cities to establish a land bank in the late 20th century. One of the main reasons that prompted the creation of this “first-generation” land bank was the failure of the outdated property tax enforcement system (Alexander, 2011). The old tax systems did not consider the scenarios of speculators buying low-value properties but not maintaining them properly, resulting in long periods of abandonment or tax delinquency that ended up being a burden on the city. Since these tax-delinquent properties often remained unsold due to excessive tax liens or cycled through repeated foreclosures without improvement, local governments were forced to take ownership of these in-debt properties (Alexander, 2011). During the 1980s and 1990s, Cleveland’s land bank helped convert vacant and tax-delinquent properties into productive use. However, despite managing up and transferring up to 500 parcels annually,

Cleveland struggled to keep pace with the volume of parcels needing intervention in the inventory, which ranged between 1,000 and 2,000 parcels per year (Alexander, 2011), highlighting that land banks sometimes lacked the capacity to fully tackle the large scale of property abandonment.

In addition to managing vacancy and controlling suburban sprawl, the role of the land banks expanded to focus on revitalizing declining urban areas over time by streamlining the vacant land redevelopment process (Alexander, 2011). One of the core functions of land banks is determining the vacant land disposition for productive reuse, transforming underutilized parcels into opportunities for economic development and community revitalization. The ultimate objective is to transfer these properties back into productive use, ideally to the point where the land bank itself is no longer needed (Alexander, 2005). This is because, before disposition occurs, land banks must manage and maintain the acquired properties, which involves tasks such as lawn care, tree maintenance, and trash removal. These maintenance responsibilities can be both costly and time-consuming, often requiring millions of dollars annually to ensure that vacant land does not become a public nuisance (Schilling & Logan, 2008). To reduce operational pressures with increasing parcels in the inventory, land banks inevitably need to dispose of some land to achieve organic circulation.

The redevelopment of vacant land can take many forms, with land banks playing a key role in facilitating property transfers for various uses. These vacant properties may be sold to developers for commercial and residential projects, transferred to community development corporations (CDCs) for initiatives such as affordable housing and public spaces, or allocated to individuals for uses like side yards. However, determining the suitable uses for vacant parcels is not easy. Financial, regulatory, institutional, and physical barriers collectively create significant challenges that need to be addressed to facilitate successful urban land redevelopment efforts (Goldstein et al., 2001). For example, redlining has historically limited access to funding for urban redevelopment projects, particularly for mixed-use developments. However, Goldstein et al. (2001) still provided some success stories, such as Portland promoting vacant land development through regional planning and urban growth boundary (UGB) policies to restrict urban sprawl outside the metropolitan area, contributing to urban infill and redevelopment. The internal reforms of the Providence, Rhode Island city government, which coordinated the processes of

vacant land management agencies and strengthened land enforcement, also contributed to resolving the vacant land issue. The establishment of an environmental cleanup fund then facilitated site remediation and penalized non-compliant landowners (Goldstein et al., 2001). This intergovernmental coordination, strict enforcement, and economic incentives created a fertile ground for the effective management of vacant land.

Addressing the complexity of vacant and underutilized parcels in Cleveland requires creativity and innovation. Procedurally, integrating technical GIS technology with innovative public engagement strategies can enhance decision-making and community involvement. To produce innovative solutions, emerging concepts mentioned earlier such as Transit-Oriented Developments (TODs), the 15-minute city model, and Nature-Based Solutions offer promising approaches to revitalizing underutilized urban spaces and fostering sustainable, inclusive growth. Successfully repurposing these vacant parcels also necessitates a departure from rigid, outdated zoning that have long restricted compact and mixed-use development and failed to respond to evolving urban needs (Goldstein et al., 2001). The next section talks about how the Cleveland Planning Commission has moved toward a more flexible, innovative, and data-driven approach to repurpose vacant land uses.

Zoning Reform

Zoning restrictions have become significant challenges for redevelopment and land use planning. Rigid zoning regulations often limit flexibility in repurposing land, while insufficient community involvement can lead to mismatched developments that fail to meet local needs. Without collaborative efforts, redevelopment projects may face delays, resistance, or ineffective land use outcomes. In the US, Zoning established by law the superiority of single-family homes and indirectly continued to maintain racial and class segregation through land-use regulations and restrictive covenants. The American zoning epitomizes suburbanization after World War II. This idea enshrines single-family homes as the ideal urban setting to embrace the “American Dream”, which was reinforced by a belief that zoning is hierarchical through Euclidean zoning ordinances (Micklow & Warner, 2014). The Supreme Court first validated the notion that the single-family lifestyle and exclusively residential zones were appropriate and legitimate in the 1926 *Village of Euclid v. Ambler Realty Corp* case in Euclid, Ohio (Village of Euclid v. Ambler Realty Co., 272

U.S. 365 (1926), n.d.). Justice Sutherland, who delivered the Court's decision, upheld the exclusion of multi-family housing from single-family districts, condemned corner stores as threats to public welfare and apartments as "parasites" that took advantage of the amenities and open spaces (Village of Euclid v. Ambler Realty Co., 272 U.S. 365 (1926), n.d.). In *Arbitrary Lines: How Zoning Broke the American City and How to Fix It*, Gray (2022) critically evaluates zoning as an inherently flawed system. Gray (2022) highlights how zoning institutionalizes exclusionary mechanisms by catering to coalition interests that prioritize certain groups over others. This exclusive approach to city planning ineffectively fossilizes neighborhoods in "amber," institutionalizes segregation, and embeds a sprawling vision of urban development.

For over eight decades, zoning in Cleveland has played a crucial role in shaping the city and serving its residents. Initially designed to address the challenges of its time, it effectively separated residential neighborhoods from the negative impacts of industrial activity, adapted to an era dominated by automobiles, and ensured the provision of green spaces as the city rapidly expanded (*Form Based Code*, n.d.). Although well-intentioned, zoning has significantly contributed to racial segregation and rigidity in Cleveland. In *Exclusionary Zoning in Cuyahoga County*, Lepley and Mangiarelli (2020) highlighted how zoning in Cuyahoga County has reinforced a power dynamic by designating 58% of the total land exclusively for single-family housing. This zoning approach has effectively preserved access to high-quality public education and homeownership opportunities for the white upper-middle class, while communities of color have been concentrated in east side Cleveland, where multi-family housing and rental properties are more prevalent (Lepley and Mangiarelli, 2020). The case study in this paper sits at the intersection of these areas, characterized by a higher density of multi-unit housing. Despite efforts to update Cleveland's code since its establishment in 1929, successive modifications have made it increasingly complex and difficult to navigate, while failing to fundamentally address the historical disparities in inequality. Such outdated zoning also stifles transformation, as cities need to evolve, adjust, and accommodate their evolving populations (Gray, 2022).

In response, the Cleveland Planning Commission argued that the existing zoning regulations are now misaligned with Cleveland's vision for the 21st century and a neighborhood approach is needed to serve as a guiding principle for future land use (*Form Based Code*, n.d.). Zoning reform can allow for higher-density and multi-family developments, addressing the exclusionary

nature of traditional zoning and fostering more dynamic communities (Bronin, 2024). Allowing such developments would not only increase housing supply but also promote inclusivity and help control rising housing costs. While Houston is an exception among U.S. cities without conventional zoning, its land-use regulations still incorporate similar zoning principles. Bronin (2024) described that Houston's policy of reducing lot sizes has encouraged residential construction and expanded affordable housing options. This flexibility has contributed to significant progress in tackling homelessness, with the city successfully housing 25,000 individuals and reducing its homeless population by 63% (Bronin, 2024). Removing zoning barriers has made housing development more adaptable and practical.

Beyond housing development, zoning reforms can also promote more vibrant and diverse land uses. After the *Kelo v. City of New London* case in 2005, some communities have redefined the land use priorities such as prioritizing commercial zoning rather than residential zoning. This realignment has the potential to create more human-centered neighborhoods by introducing mixed-use developments that enhance convenience for residents (Micklow & Warner, 2014). Additionally, zoning reforms can help curb urban sprawl, promote multi-modal transportation, and support environmentally sustainable urban growth (Gray, 2022). Such reform is crucial for building more equitable, dynamic, and sustainable communities that can adapt to changing needs and meet the demands of present and future generations.

In Cleveland, the zoning reform started initial pilot projects through the Form-Based Code in Detroit Shoreway/Cudell, Hough and the Opportunity Corridor, as designated by the City Planning Commission (Cleveland Form Based Code Project, 2019). The Cleveland Neighborhood Form-Based Code was designed to promote more consistent outcomes and enhance the quality of the public realm by defining the physical structure of buildings. It regulates the relationship between building facades and public spaces, the form and scale of buildings relative to one another, and the layout and character of streets and blocks (*Cleveland-Form-Based-Code-REV.Pdf*, n.d.). The Cleveland City Planning Commission launched the LandCode initiative, introducing the new code and piloting it in Detroit Shoreway/Cudell, Hough, and the Opportunity Corridor with on-going public viewing. This project aims to enhance transportation alternatives, create walkable and healthy neighborhoods, and promote diverse housing options. By fostering a vibrant urban experience, it seeks to attract businesses and new

residents, ultimately contributing to the city's revitalization (*Cleveland's New Form Based Code*, 2024). This zoning reform reflects a broader shift toward data-driven and community-informed urban planning.

Transit-Oriented Development

The Manager of Strategic Planning for the Cleveland Planning Commission Matt Moss (2024) argues that Cleveland's historic streetcar lines have served as the backbone for brownfield redevelopment and urban infill. However, since the 1950s, increasing auto dependency has diminished many pedestrian-friendly spaces. By implementing Transit-Oriented Development strategies, Cleveland can foster more sustainable and equitable urban growth. Transit-Oriented Development (TOD) promotes a compact, mixed-use design that integrates land use with transit systems, focusing on medium to high density development and walkable, bike-friendly areas near transit hubs (Liu et al., 2020). This development has an intention to promote smart growth, inject vitality into declining inner-city settings, and expand lifestyle choices, such as expanding community accessibility and encouraging public transportation (Cervero & Program, 2004; Singh et al., 2017). In urban planning, TOD also highlights the advantages of compact and well-integrated land uses connected by high frequency transits and transportation nodes (Kaniewska et al., 2024).

The concept of TOD was developed by Calthorpe (1993) as a planning model that emphasizes high-density development, diverse land uses, and pedestrian or cyclist-friendly environments around transit stations. This prototype has shaped most TOD practices through various applications across the world. Calthorpe (1993)'s TOD model can be expanded to corridor and regional scales. Calthorpe (1993) argued a main transit line could encompass several TOD nodes, creating a series of TODs along the transit route to enhance efficiency. These chains can interconnect, establishing a corridor-based regional network of TODs. In Cleveland, the proposed Transportation Demand Management (TDM) program aims to support Transit-Oriented Development (TOD) and foster reinvestment within the core of Cleveland neighborhoods. This program applies to new developments and major renovation projects situated within a ¼ mile of high-frequency transit stops, where high-frequency transit is defined

as bus or rail services operating at 15-minute intervals (*Cleveland Takes Big Steps toward Mayor Bibb's Vision for a 15-Minute City | City of Cleveland Ohio*, n.d.). Based on this rule and transportation data from the Greater Cleveland Regional Transit Authority (RTA), the City Planning can utilize transit stops as TOD nodes to map out TOD corridors and regional zones.

TOD serves not only as a tool for enhancing areas with insufficient land use elements, but also as a strategy for leveraging existing strengths in areas with high potentials. Bertolini (1999) argues that under the principles of TOD, land use and transportation need to be closely integrated to achieve more efficient and sustainable urban development. In unsustained nodes with strong transit connections but lacking in employment, services, and housing, TOD planning should concentrate on enhancing these land use elements. This model has been widely used and expanded in numerous TOD studies to plan and evaluate the alignment of integrated land use and transit. However, Ibrahim et al. (2023) proposed that TOD levels are conducive to promoting TOD project outcomes, and areas of high potential and interest are more conducive to successful and effective programs.

However, when examining the Buckeye-Woodhill area in Figure 2, it becomes clear that the neighborhood only has coverage from the transit buffer but lacks a strong community foundation. The 2020 U.S. Census data on population and housing units can be used to visualize the transit-supportive potential of specific census blocks and neighborhoods. The dark blue areas represent those that exceed the threshold for transit support, while the absence of dark blue coverage indicates that the area's population density or housing unit count is insufficient to effectively support public transportation. According to the *Transportation Research Board* (2004), for premium bus service, a minimum of 15-18 dwelling units per acre is recommended to support efficient transit use and encourage TOD. The GIS mapping suggests that the Buckeye-Woodhill neighborhood is not suitable for or has not yet fully developed TOD, and further enhancement of land use elements such as increasing residential, commercial, or employment opportunities is needed to strengthen its transit support capacity (Figure 2).

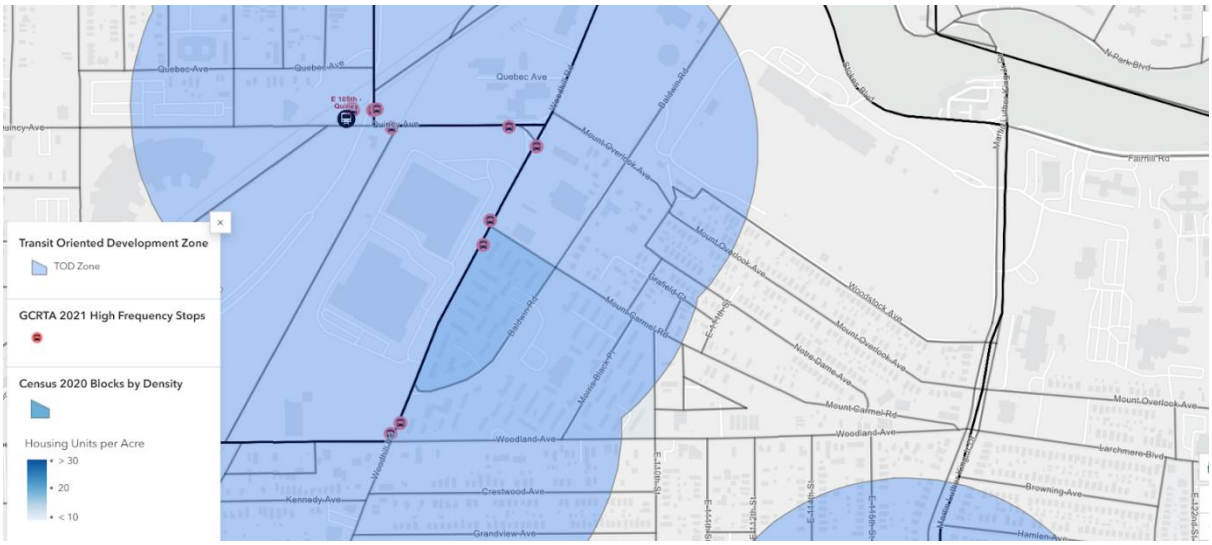


Figure 2 Buckeye-Woodhill Neighborhood Transit Support and Development Potential (Moss, 2024)

Drawing from RTA's TOD best practices, the Buckeye-Woodhill area can implement TOD initiative by increasing residential units to promote higher-density housing, which in turn supports the efficient operation of premium bus services. Rather than large-scale, one-time development, Cleveland can adopt a phased approach, developing small-scale projects on scattered parcels as pilot initiatives to build experience and learn from success. Additionally, integrating affordable housing with TOD can serve as an effective strategy to expand the supply of affordable housing. One of the core advantages of TOD is providing convenient public transportation options, allowing residents of affordable housing to reduce car dependence and, consequently, lower their overall living costs (TOD - Best Practices | RideRTA, n.d.).

15-minute City

Together with TOD, the 15-minute City concept emphasizes dense urban environments that prioritize pedestrian access and reduce reliance on private vehicles, enhance urban livability and environmental resilience, and conserve land for other environmental purposes (Allam et al., 2023). The Cleveland mayor Justin Bibb and the administration aim to transform Cleveland into a more appealing, desirable, safer place to live, work, and enjoy life. The vision of the 15-minute city aims to make it easy for residents to meet their basic needs by walking, biking or taking public transport for short distances (*Cleveland Takes Big Steps toward Mayor Bibb's Vision for a 15-Minute City | City of Cleveland Ohio*, n.d.).

This initiative is considered an antidote to solving urban shrinkage by encouraging proximity and walkability. The new zoning under the Form-Based Code and the existing transportation infrastructure are aimed to shift the land uses toward making Cleveland a "15-minute city,'' where daily needs can be met within a short walk (15-minute) from home. Cleveland's zoning over the past 100 years has made it more difficult for people to access different uses by strictly separating them. However, a more flexible Form-Based Code is beneficial for efficiently and equitably redesigning Cleveland, as it focuses on the form of buildings rather than strictly regulating the internal uses. This approach supports the realization of a 15-minute city (*Cleveland's new form-based code may change the look and feel of "The Land.," n.d.*).

The Cleveland Planning Commission has created a GIS accessibility map that identifies key points of interest related to the 15-minute city concept utilizing 15-minute walkshed and various city amenities (*15 Minute City Points of Interest*, n.d.). This map highlights locations within the city that are essential for residents to access basic services and amenities within a short walk, bike ride, or transit trip, supporting more efficient and sustainable urban planning. Examples of walkable Cleveland neighborhoods that already fit within this 15-minute city framework include Ohio City, Little Italy, Tremont, Detroit-Shoreway, and Larchmere. These areas reflect the potential for Cleveland to become a more walkable and connected city, with neighborhoods that provide residents easy access to their daily needs without relying on private cars.

Nature-Based Solutions

Cleveland is actively embracing global efforts to tackle climate change by prioritizing Nature-Based Solutions (NBS). After the United States joined the global platform to advance Nature-Based Solutions, known as the Enhance Nature-Based Solutions for an Accelerated Climate Transformation (ENACT) partnership, Cleveland has embraced this initiative (*Biden-Harris Administration Expands Use of Nature-Based Solutions to Better Protect Communities from the Impacts of Climate Change | OSTP*, 2023). The City seeks to prioritize Nature-Based Solutions (NBS) to enhance resiliency and secure healthy natural ecosystems. These solutions involve protecting, managing, or restoring natural or altered ecosystems in order to address societal challenges, while simultaneously delivering benefits for both people and the environment

(*K2200677 - United Nations Environment Programme -Environment Assembly.5-Res.5 - Advance.Pdf*, n.d.). However, while this agenda is aligned with global trends, Cleveland's progress may face greater challenges under the Trump administration due to unstable funding and shifting political circumstances. Despite these obstacles, the city remains committed to advancing sustainable solutions.

Among various ways for redeveloping vacant lots, greening through expanding tree canopy and creating community green and open spaces can stabilize urban ecosystems, lower crime fears, and improve well-being of residents (Gobster et al., 2020). The disadvantaged and low-income neighborhoods have been disproportionately accessing green spaces, resulting in environmental and public health inequality (Rigolon, 2016). Greenspaces provide residents with significant outdoor spaces for physical activities, and they bridge the gap between urban shrinkage and sustained ecosystem services, serving as potential areas for improving regional greenspace networks (Burkholder, 2012). Specifically, they deliver essential ecosystem services and functions, including enhancing air quality, reducing the urban heat island effect, mitigating flooding, and improving biodiversity (Burkholder, 2012). Moreover, greenspaces can promote resident well-being by acting as hubs for social gatherings and places that reinforce local identity and strengthen social ties (Basu, Hashimoto and Dasgupta, 2020).

It is expected that Cleveland will achieve sustainable development while enhancing urban resilience and the overall quality of life for its residents by leveraging NBS, such as improving tree coverage, land conservation, and the restoration and preservation of natural areas (Croeser et al., 2021). Greening vacant lots is not just an immediate solution, but a long-term, cost-effective investment that can offer both environmental and social benefits (Mallach, 2018). Mallach (2018) encourages us to rethink vacant properties as opportunities for green infrastructure, such as small parks, urban farms, and community gardens. Although these programs require initial investment in the beginning, they are highly cost-effective in the long run as they reduce costs related to stormwater management, energy consumption, and public health. Cleveland has taken significant steps in this direction. The CDC Cleveland Neighborhood Progress (CNP) recently conceived a vision for transforming vacant lots into valuable community assets. The *Reimagining Cleveland: Ideas To Action* provided by CNP and other organizations provides a catalog of alternative green uses for vacant lots, complete with cost and material requirements for implementation (*Re-*

Imagining Cleveland Ideas To Action Resource Book, 2011 1, n.d.). This manual is a valuable resource for city officials, community organizations, and developers, playing a critical role in supporting Cleveland's efforts to enhance urban resilience and sustainability.

METHODOLOGY

Study Area: Buckeye Woodhill

Given all the GIS applications in Cleveland mentioned in the previous chapter, we turn now to a specific case study where GIS applications and ground-truthing were combined to create a more cohesive/coherent set of potential land use frameworks. The case study is the neighborhood of Buckeye-Woodhill which I investigated alongside the Cleveland Planning Commission, Western Reserve Land Conservancy, Burten, Bell, Carr Development, Inc., during my internship with WRLC.

To model the methodology, the Cleveland Planning Commission had conducted a data-driven analysis and ground-truthing with CDC members, such as Slavic Village Development, and residents in the Slavic Village neighborhood to test and refine the details of a similar process to prioritize vacant land uses. This helped the project developers to learn from this pilot project and utilize the knowledge gained from the pilot project in the geography of Buckeye-Woodhill.

I participated in the process of developing a vacant land prioritization model with the Planning Commission and other CDCs to replicate the project in a designated triangular block in Buckeye-Woodhill. As shown in Figure 3 and 4, this triangular area was chosen due to its strong community network, which offered an opportunity to leverage these connections and carry out ground-truthing.

Looking back at historic trends, our current study area had more housing in the early 20th century than it does now. From Cleveland maps dating from 1927 to 1937, the area once had a denser distribution of housing, whereas now many areas that were originally residential have been demolished and replaced with vacant land (Figure 5). This demonstrates the potential for this area to be revitalized by more compact uses. Currently, there is significant development occurring in this area, with many neighborhood plans still in progress. This helped community development corporations identify this area of interest.

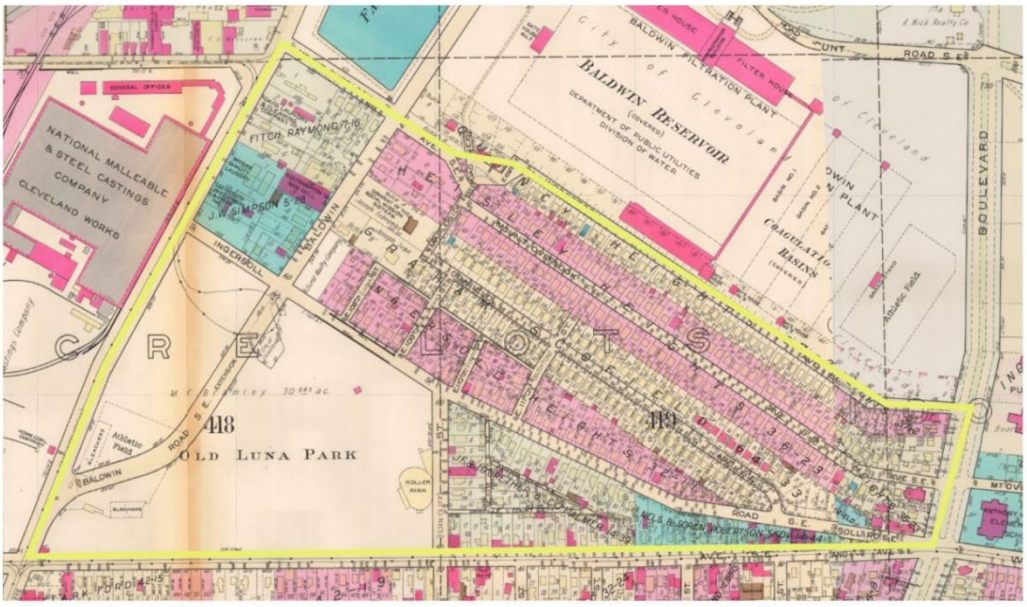


Figure 3 Historical Map (1927-1937)

Figure 4 Satellite Image (Cleveland Historic Maps, n.d.)

Figure 5 A zoomed-in before-and-after comparison of the selected area

Buckeye-Woodhill is a Cleveland neighborhood and a Statistical Planning Area. According to the 2022 Census (Figure 6), vacant housing units account for 19.1% in this neighborhood, and the unemployment rate is as high as 13.71%, higher than the citywide level of 11.91%. Additionally, the median household income is much lower than the city average. This neighborhood experiences high vacancy rates, along with poverty issues, because of historical redlining practices. According to the City of Cleveland Property Inventory (2023), which records the current status of land parcels, Buckeye-Woodhill not only faces a vacant land crisis, but also deals with poorly maintained vacant lots that pose a threat to community health. Addressing these challenges through strategic redevelopment and community-driven efforts is crucial for revitalizing and improving the overall well-being of the neighborhood.

Total Housing Units (ACS 2022 5-year)			
	Total	SPA percentage	City-wide percentage
Vacant Housing Units	527	19.1	16.38
Unemployment (ACS 2022 5-year)			
	Total	SPA percentage	City-wide percentage
Unemployment	251.97	13.71	11.91
Median Household Income (ACS 2022 5-year)			
		SPA median	City-wide Median
Income		25696	37180

Figure 6 Buckeye-Woodhill 2022 census data, provided by NEO CANDO

Buckeye-Woodhill, despite facing significant challenges, is experiencing promising developments through various community initiatives and infrastructure projects. To the west of the area, there are initiatives like the Opportunity Corridor, focusing on the core job zone and urban agricultural zone uses (*Cleveland City Planning Commission*, n.d.-b). Burten, Bell, Carr Development, Inc. (BBC) has partnered with the City of Cleveland and the Fund for Our Economic Future to gather hundreds of acres for redevelopment around the Opportunity Corridor. The three-mile thoroughfare, completed in 2021, connects I-490 to University Circle, and traverses a proposed "job zone" that includes the northern part of Buckeye-Woodhill (*BUCKEYE-WOODHILL | Encyclopedia of Cleveland History | Case Western Reserve University*, 2022). In the central part of the neighborhood, there is "Elevate the East," a community-led effort guiding public art investments (*Elevate the East*, n.d.). Additionally, in 2021, the Department of Housing and Urban Development (HUD) awarded a $35 million Choice Neighborhoods Implementation grant to Cuyahoga Metropolitan Housing Authority (CMHA) and the City of Cleveland, in partnership with The Community Builders (TCB), to support the Buckeye-Woodhill Transformation Plan, a housing initiative that encourages recreation and walkability (*Buckeye-Woodhill: Framework for a 15-Min Neighborhood - Overview*, n.d.; *PROJECT UPDATES*, n.d.). With the help of over 200 collaborative partners, CMHA, the City of Cleveland, and The Community Builders are leading the revitalization of Woodhill Homes and the surrounding Buckeye-Woodhill community. This grant ensures equitable and mix-use neighborhood development in this southeast Cleveland neighborhood (*PROJECT UPDATES*, n.d.).

Positive momentum is being generated by local organizations such as BBC, implementing plans to lift the Buckeye neighborhood from a history of disinvestment, the impact of race-based housing policies, and population loss. While stark statistics about population loss and poverty present challenges, there is also significant effort being made to uplift the neighborhood. Over the years, BBC and its numerous partners have focused on addressing the wants and needs of the Buckeye community. With community support, they have developed projects such as the *We Are Buckeye* Neighborhood Plan, *Elevate the East* Guide, *the Buckeye Road Refresh* Planning Study, *the Community Health Needs Assessment (CHNA)*, and more (*Buckeye – Burten, Bell, Carr Development, Inc.*, n.d.). Western Reserve Land Conservancy is dedicated to addressing vacant and abandoned properties and preserving urban green spaces. They created vibrant green areas

like the Ubuntu Gathering Space and the Woodhill Community Garden in partnership with local organizations (Shaheen, 2023). By collaborating with various organizations to promote sustainable development and social capital, Buckeye-Woodhill has embraced new opportunities. This ongoing transformation will foster a better environment for the community and have a lasting impact on future generations.

GIS-based Model to Prioritize Land Uses

To support this existing community efforts and city-wide initiatives, we were tasked with providing a GIS-based model to understand specific opportunities and challenges in Buckeye-Woodhill. I collaborated closely with the Planning Commission's technical staff and planners to gain a comprehensive understanding of the entire process. I first studied the pilot project in Slavic Village to learn how to replicate the model for the new pilot in Buckeye-Woodhill. Later, I participated in the development and optimization of the current model for the new pilot in Buckeye-Woodhill. Alongside the technical staff, I contributed to its on-site implementation. Additionally, I took part in resident concept training and the ground-truthing process, gaining a deeper understanding of the model's practical applications and identifying potential strategies for improvement.

During my internship, I documented the GIS-based model application in detail and submitted a comprehensive report to the Planning Commission, ensuring the process could be referenced and applied in future projects. This model, developed within a structured three-month framework, integrates data-driven planning with community engagement to produce informed and actionable land use strategies.

Ground-truthing (methods/outcomes of pilot in Slavic Village and potential for Buckeye-Woodhill)

Figure 7 illustrates the three-phase collaborative planning process implemented: an initial planning phase, a ground-truthing phase, and a debriefing and deliberation phase, each lasting approximately one month. The process was divided into three phases: during the **Initial Planning Phase (1 Month)**, planning experts utilized GIS tools and input from various city

departments, the council, and CDCs to develop preliminary land use recommendations. At the same time, residents were trained in fundamental planning concepts and the technology used for ground-truthing. During the **Ground-truthing Phase (1 Month)**, residents conducted on-the-ground surveys to validate or contest the preliminary land use recommendations based on firsthand observations. In the **Debriefing and Deliberation Phase (1 Month)**, stakeholders and residents reviewed findings from the ground-truthing phase and deliberate to resolve discrepancies. The City then finalized a report with pre-approved land use recommendations, providing a resource for investors seeking alignment with the City's planning goals. This methodology provides a replicable framework that can be applied to other regions, offering a structured approach to land use planning.

Rather than acting as a standalone solution, the model served as a crucial bridge—translating technical planning tools into a participatory framework that foregrounded local voices. While the core planning activities unfolded within three months, the success of the model hinged on pre-existing community relationships and would require ongoing engagement and follow-through to realize its long-term goals. Before the model was even implemented, the neighborhood had a strong foundation of collaboration and trust. The area was already supported by existing transit infrastructure, and the local CDCs had built long-standing communication channels with residents. City Planning had also developed spatial datasets and preliminary analyses, while the CDCs had conducted parcel-level land inventories. There was already shared consensus among the City, CDCs, and residents on key priorities. Following the release of the final recommendations, investors would be encouraged to align their projects with the plan's priorities. Not all proposed interventions would attract investment right away, and some might take years to realize.

Ground-truthing served as the cornerstone of this planning project, acting as a pivotal component that brought the community's voices into the decision-making process. During the ground-truthing phase, the program was a collaborative effort involving the City Planning Commission, the Western Reserve Land Conservancy, and CDCs, along with participation from resident volunteers.

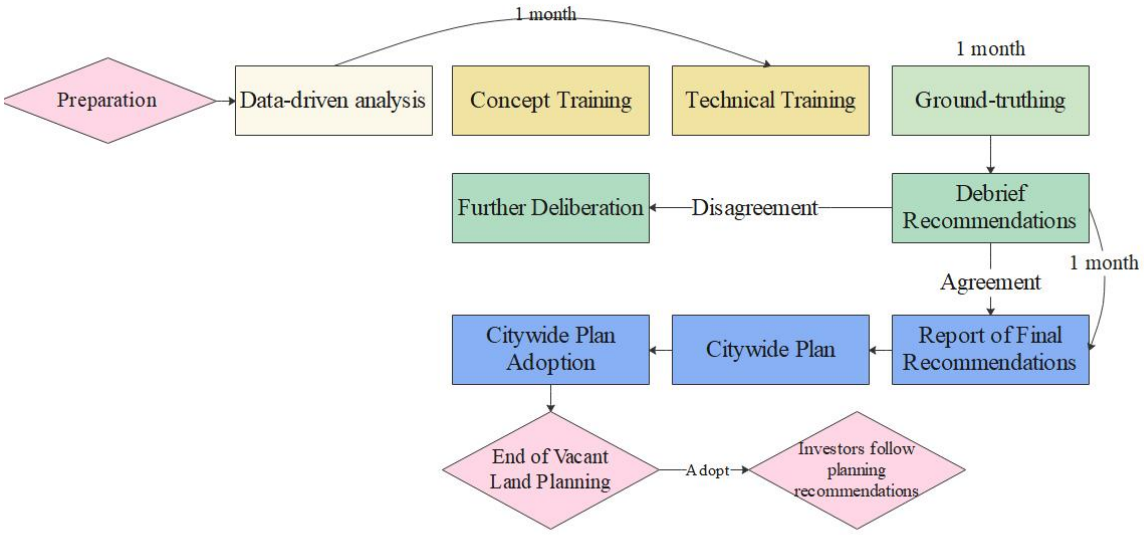


Figure 7 Flowchart of the ground-truthing process

Following the pilot implementation in Slavic Village, we developed a streamlined ground-truthing roadmap that could be replicated in other neighborhoods (Figure 7). In the Slavic Village neighborhood, after a data-driven planning proposal was developed, the City spearheaded concept training sessions for resident volunteers in the Slavic Village neighborhood. Community development corporations (CDCs), including the Western Reserve Land Conservancy (WRLC) and the Green Team from Slavic Village Development, played an active role in supporting community engagement efforts throughout the process. The concept training included understanding the concept of ground-truthing, planning/development concepts that guide the City initiatives, and the criteria for verification during field assessments, as well as addressing common concerns among residents regarding issues like mix-use development and gentrification. The session also involved teaching residents how to use the survey application on their smartphone apps, ensuring accurate responses and assisting with the survey. As planning professionals, we also presented GIS-based maps of the area, a comprehensive inventory of vacant land in the Slavic Village neighborhood, showing our land use recommendations derived from GIS spatial analysis (Figure 8). After training, CDC staffs guided residents in their jurisdictions through the ground-truthing process, while areas not covered by CDCs were supported by the City.

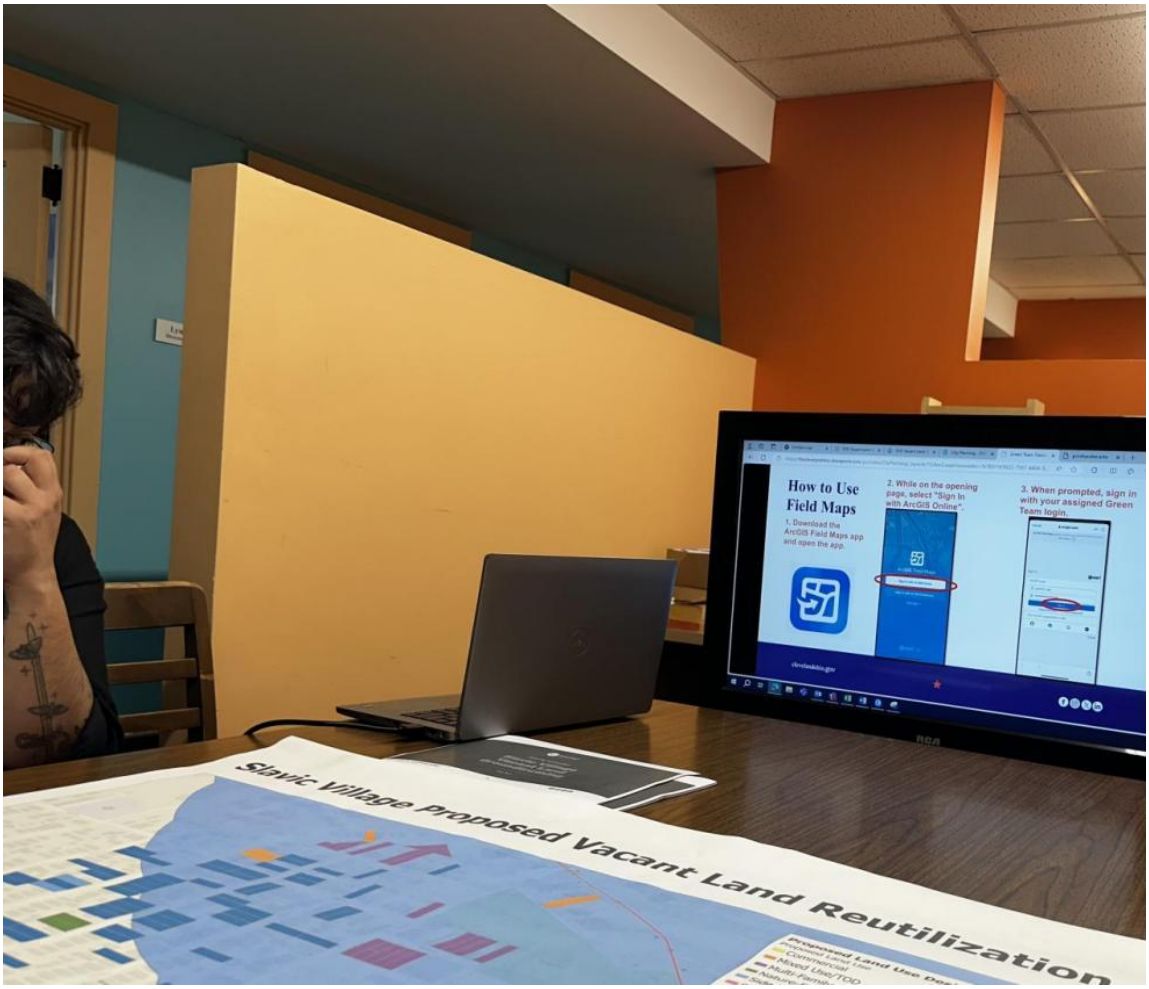


Figure 8 Concept Training in Slavic Village

During ground-truthing in Slavic Village, residents worked in pairs, and through conversations, they sparked discussions about the future of their community. At each parcel, they answered a survey, took photos, and provided specific recommendations for special lots, which were all submitted to "Field Maps." In the initial stages, residents conducted ground-truthing with the assistance of Planning Commission staff and CDC members together (Figure 9 & 10). However, as the process progressed, they independently assessed the remaining parcels, and their inputs were recorded in the "Field Maps." Later, the Planning Commission's technical staff reviewed the feedback and adjusted the land use mapping recommendations accordingly.

Figure 9 The Green Team guided Slavic Village residents in using “Field Maps”

Figure 10 Ground-truthing in Slavic Village

A structured debrief process was conducted to analyze the findings, categorizing feedback into “agree” and “disagree.” These findings were then reviewed by technical planning professionals in the Planning Commission. Suggestions deemed feasible and aligned with planning objectives were incorporated into city-wide land use strategies, often compiled in a memo or report shared with public stakeholders and potential investors. However, if suggestions were rejected, they were re-evaluated in follow-up sessions, leaving space for ongoing dialogue. The results informed a comprehensive land bank memo or report aimed at public transparency and collaborative decision-making. The entire planning cycle—from data-driven analysis, concept training, fieldwork, and debrief—took approximately three months and emphasized public transparency, equitable input, and iterative refinement of planning decisions.

GIS/GROUND-TRUTHING PROCESS

Identify Vacant Parcels

Property inventory data was used as a source to locate vacant parcels from land banks or private entities. In this study, the 2022 data named "Citywide Property Survey 2022" provided by WRLC was utilized. It was extracted from City of Cleveland Open Data (n.d.); the "Cleveland Citywide Property Survey 2022 Parcels" folder was used since it contains the most comprehensive and up-to-date property survey data of our study area.

The boundary for the study area was identified in GIS with a shapefile (Figure 11). In other research, the study site can be of various geographical scales, such as census tracts or statistical planning areas, depending on the intention and feasibility of research. We chose the parcels in our study area and reduced the dataset volume through *Select by Location* Tool (Figure 12). With this technique, we ensured that the selected land parcels were mostly located within the designated block, thereby avoiding parcels being restricted by the rigid boundary line. After that, we cleaned up the attribute table, leaving only the data we needed (See Appendix). Finally, we used the *Property Category* column in the attribute table to select "Vacant Lot" and filter our study on vacant land by using the *Select by Attributes* Tool.

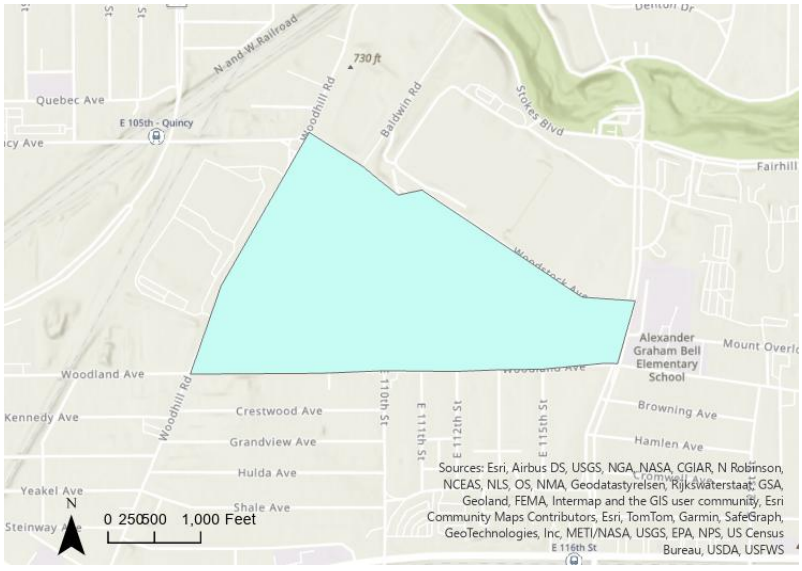


Figure 11 Study Area in Buckeye-Woodhill

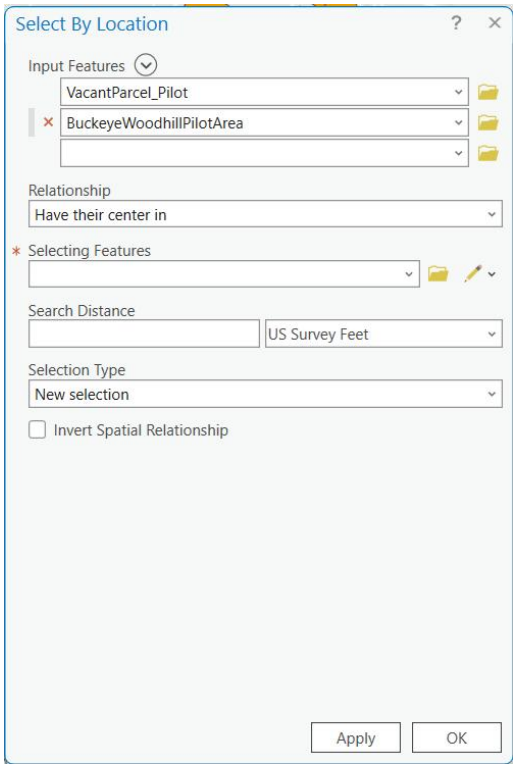


Figure 12 Choosing "Have their center in" in *Select by Location*

Identify Transit Lines and Buffer Zones

The Transit-Oriented Development Zone (TOD Zone), as defined by City Chapter 301.02, is the area within ¼ mile buffer around high-frequency transit stations, where service headways of 15 minutes or less are provided (*CHAPTER 301 - TRANSIT ORIENTED DEVELOPMENT AND TRANSPORTATION DEMAND MANAGEMENT*, n.d.). The transit stops in Buckeye/Woodhill were mapped using RTA data, and through buffer operation of the Spatial Analyst tool in GIS, the transit buffer zones were created within a ¼ mile around the high-frequency transit stops. In addition to the data named TOD Zone that needs to be imported into ArcGIS, another layer of data, "GCRTA 2021 High Frequency Routes," was also used to examine how high-frequency transit specifically impacts the community. Both the TOD Zone and GCRTA data can be found on the City's Open Data Portal.

Calculate 15-Minute City Index Heat Map

In response to the City's initiative, the City Planning conducted mapping of key nodes, performed 15-minute walkshed analysis, and carried out overlay analysis to support the development of accessible, well-connected neighborhoods (Figure 7). The 15 Minute City Index (ranked out of 36) results from a weighted sum analysis of walkable areas surrounding points of interest identified by the Cleveland City Planning Department. The various locations are aggregated based on their assigned weights to generate a comprehensive index score (15 Minute City Index, n.d.). High-scoring areas (30 or higher) indicate greater opportunities for human interaction, while lower-scoring areas (below 25), excluding industrial or transportation corridors, such as rail or highways, demonstrate areas with fewer amenities and services (Figure 13).

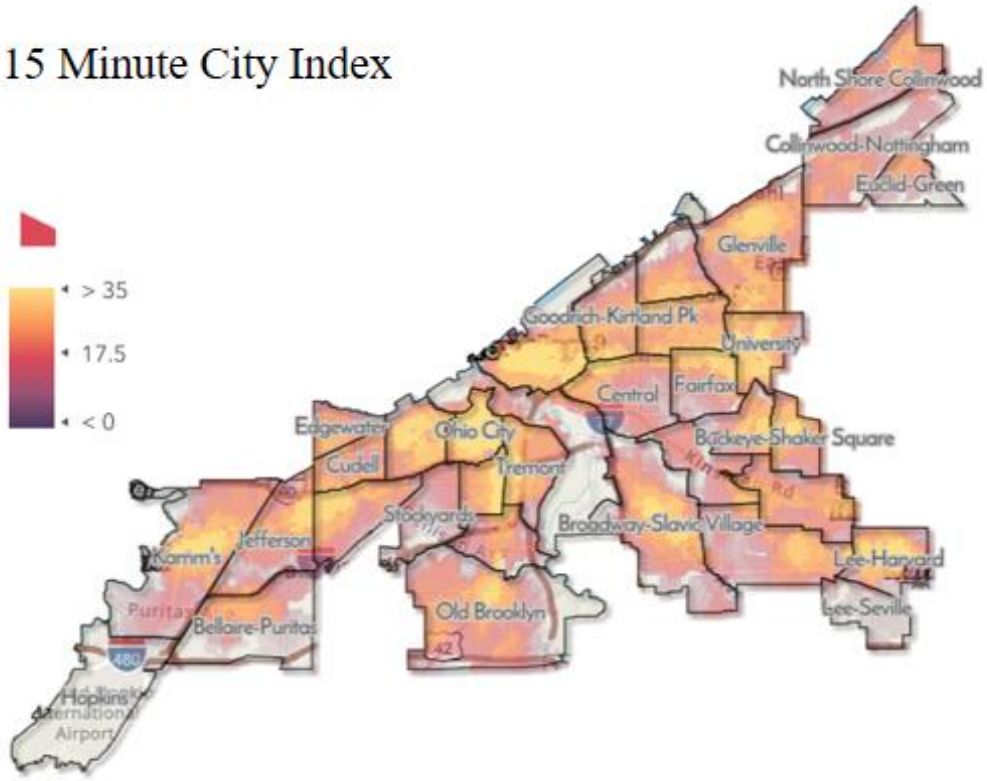
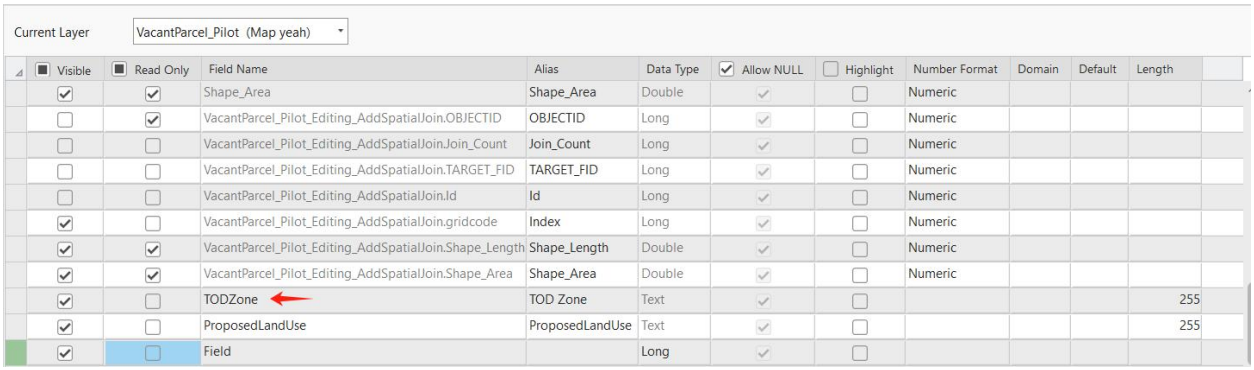


Figure 13 15-Minute City Index Heat Map that highlights current nodes of access to services & amenities (*Cleveland's 15-Minute City Journey, n.d.*)

Prioritize and Designate Land Uses Using TOD

The following steps involve prioritizing land use to enhance intensive land utilization. We used chosen datasets by filtering them with specific criteria, such as TOD and 15 minute-city index, and then calculated them to find where they overlap. The designation of land uses was carried out to facilitate data-driven preliminary planning analysis. However, after being informed by data-driven procedures, the model required professional consultation and field validation by residents, coordinating to finalize agreed-upon land use recommendations.

For parcels within transit buffers, higher density and mixed-use development were designated. First, we created a new field named "TOD Zone" (Figure 14). Then, we selected the parcels that fall inside the TOD Zone. For selecting parcels here, we used the *Select by Location* method to ensure that parcels are appropriately considered by using the "have their centers in" criterion. Then, we specified "Yes" for those in the TOD column, and similarly, specified "No" for those not in the TOD Zone (Figure 15). Additionally, this operation includes adding a new field to the table containing information regarding TOD Zone (Figure 16).


Current Layer: VacantParcel_Pilot (Map yeah)

Visible	Read Only	Field Name	Alias	Data Type	Allow NULL	Highlight	Number Format	Domain	Default	Length
☑	☑	Shape_Area	Shape_Area	Double	☑	☐	Numeric			
☐	☑	VacantParcel_Pilot_Editing_AddSpatialJoin.OBJECTID	OBJECTID	Long	☑	☐	Numeric			
☐	☐	VacantParcel_Pilot_Editing_AddSpatialJoin.Join_Count	Join_Count	Long	☑	☐	Numeric			
☐	☐	VacantParcel_Pilot_Editing_AddSpatialJoin.TARGET_FID	TARGET_FID	Long	☑	☐	Numeric			
☐	☐	VacantParcel_Pilot_Editing_AddSpatialJoin.Id	Id	Long	☑	☐	Numeric			
☑	☐	VacantParcel_Pilot_Editing_AddSpatialJoin.gridcode	Index	Long	☑	☐	Numeric			
☑	☑	VacantParcel_Pilot_Editing_AddSpatialJoin.Shape_Length	Shape_Length	Double	☑	☐	Numeric			
☑	☑	VacantParcel_Pilot_Editing_AddSpatialJoin.Shape_Area	Shape_Area	Double	☑	☐	Numeric			
☑	☐	TODZone	TOD Zone	Text	☑	☐				255
☑	☐	ProposedLandUse	ProposedLandUse	Text	☑	☐				255
☑	☐	Field		Long	☑	☐				

Figure 14 Attribute Table of the Vacant Parcel Dataset

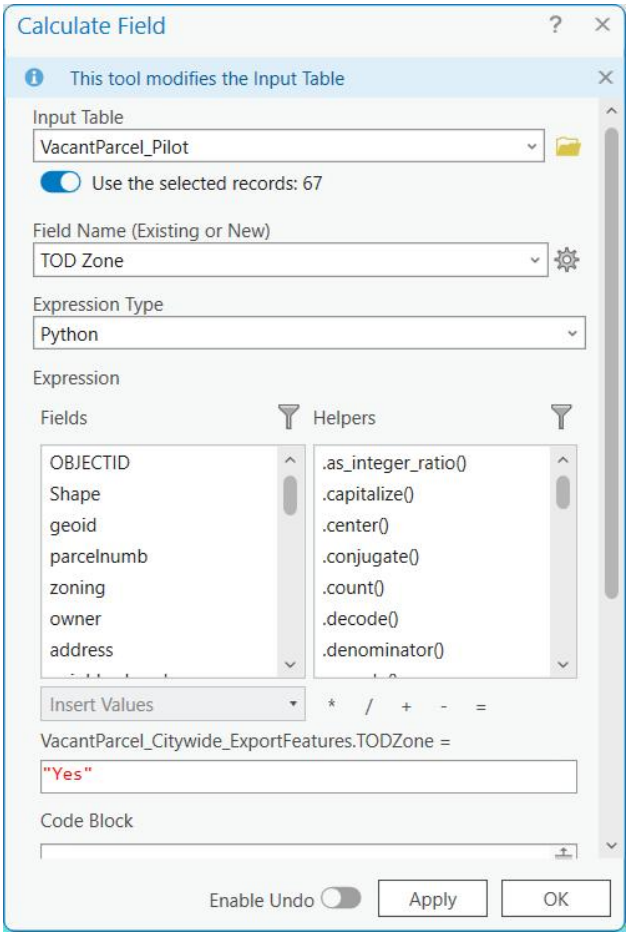
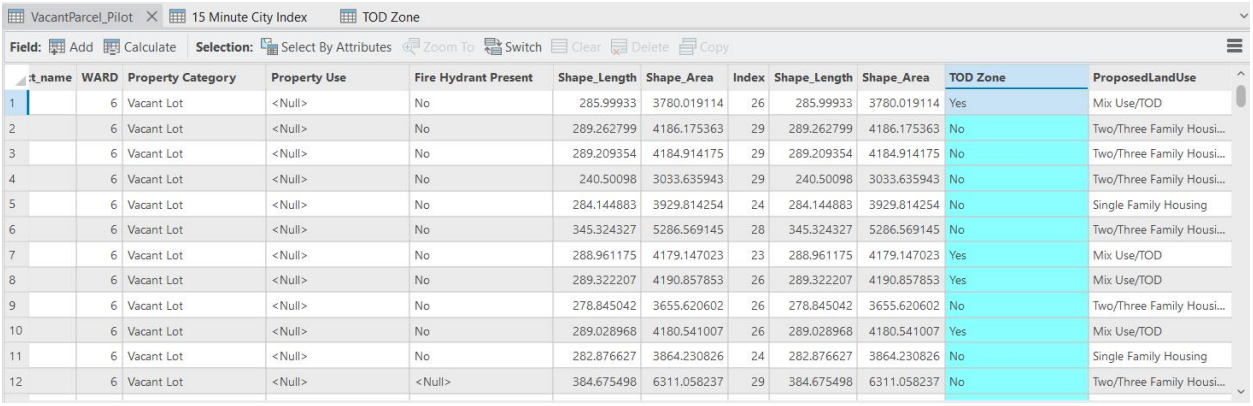


Figure 15 Use *Calculate Field* to Define the Vacant Parcels



VacantParcel_Pilot | 15 Minute City Index | TOD Zone

Field: Add Calculate | Selection: Select By Attributes Zoom To Switch Clear Delete Copy

	t_name	WARD	Property Category	Property Use	Fire Hydrant Present	Shape_Length	Shape_Area	Index	Shape_Length	Shape_Area	TOD Zone	ProposedLandUse
1		6	Vacant Lot	<Null>	No	285.99933	3780.019114	26	285.99933	3780.019114	Yes	Mix Use/TOD
2		6	Vacant Lot	<Null>	No	289.262799	4186.175363	29	289.262799	4186.175363	No	Two/Three Family Housi...
3		6	Vacant Lot	<Null>	No	289.209354	4184.914175	29	289.209354	4184.914175	No	Two/Three Family Housi...
4		6	Vacant Lot	<Null>	No	240.50098	3033.635943	29	240.50098	3033.635943	No	Two/Three Family Housi...
5		6	Vacant Lot	<Null>	No	284.144883	3929.814254	24	284.144883	3929.814254	No	Single Family Housing
6		6	Vacant Lot	<Null>	No	345.324327	5286.569145	28	345.324327	5286.569145	No	Two/Three Family Housi...
7		6	Vacant Lot	<Null>	No	288.961175	4179.147023	23	288.961175	4179.147023	Yes	Mix Use/TOD
8		6	Vacant Lot	<Null>	No	289.322207	4190.857853	26	289.322207	4190.857853	Yes	Mix Use/TOD
9		6	Vacant Lot	<Null>	No	278.845042	3655.620602	26	278.845042	3655.620602	No	Two/Three Family Housi...
10		6	Vacant Lot	<Null>	No	289.028968	4180.541007	26	289.028968	4180.541007	Yes	Mix Use/TOD
11		6	Vacant Lot	<Null>	No	282.876627	3864.230826	24	282.876627	3864.230826	No	Single Family Housing
12		6	Vacant Lot	<Null>	<Null>	384.675498	6311.058237	29	384.675498	6311.058237	No	Two/Three Family Housi...

Figure 16 Whether the Parcels Fall Within TOD Zones

Prioritize and Designate Land Uses Using 15-minute City Index

This step follows the TOD prioritization and utilizes the 15-Minute City Index to determine prioritized land uses, focusing on more compact and mixed-use areas. For parcels with a 15-minute city score of 30 or higher but off the main corridor, we designated them for multi-family housing. The process primarily utilizes the selected datasets through *Spatial Join*, followed by using syntax to select the target parcels. First, we applied *Spatial Join* to link the 15-minute index to our vacant land dataset (Figure 17). Then, we calculated the mean index value of each vacant parcel and ensured that the newly calculated index for each parcel reflected the average index for the entire parcel (Figure 18 & 19). Later on, we created a new field named "Proposed Land Use", recording and editing the uses of vacant land. Then, we sorted out the uses for vacant parcels by their relative locations of TOD Zone and index value ranges using *Select by Attribute*s (Figure 20).

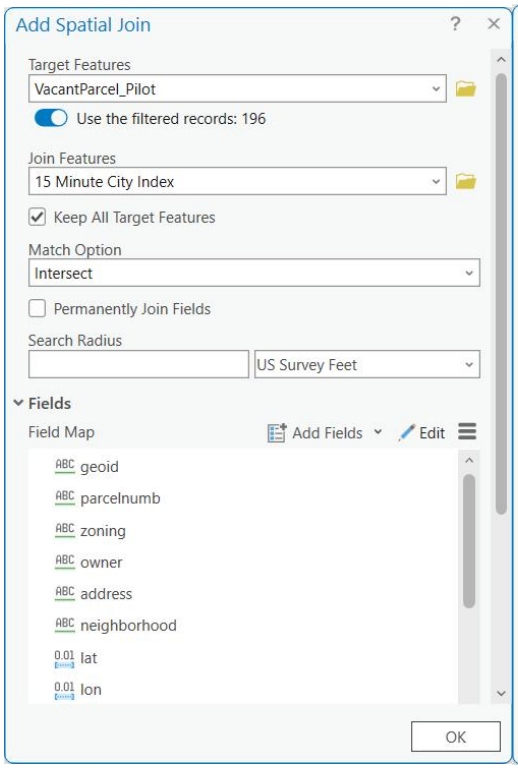


Figure 17 Add *Spatial Join*

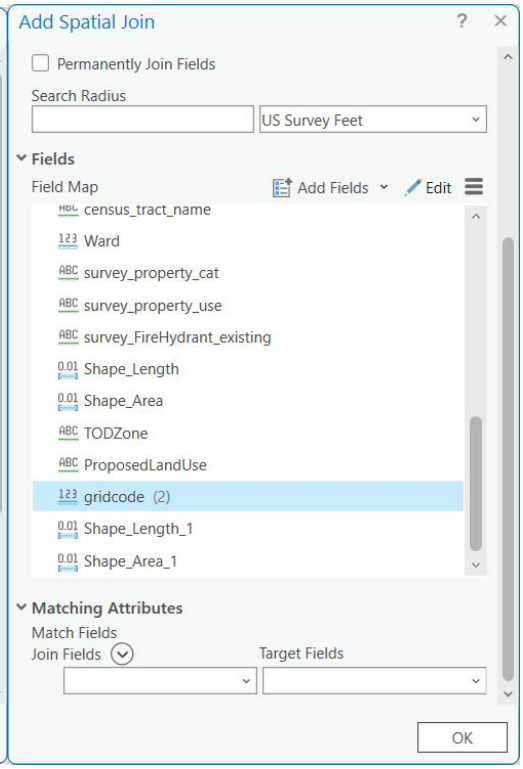


Figure 18 Use "gridcode" to Calculate Index

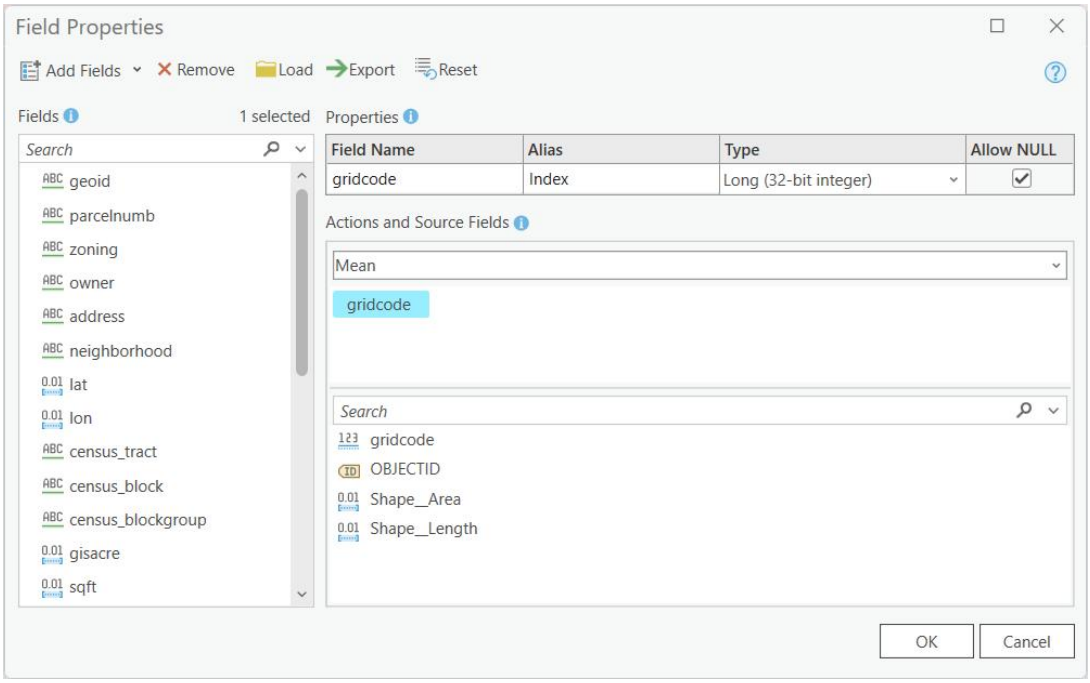


Figure 19 Calculate the Mean Index

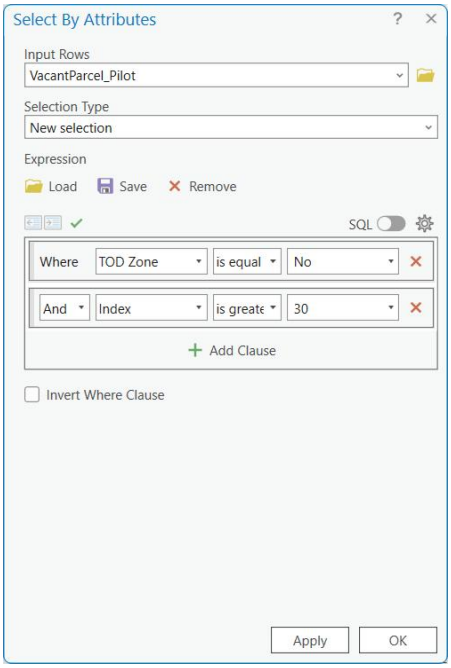


Figure 20 *Select by Attributes*

For parcels near existing commercial areas, we consolidated for commercial use. We reviewed the existing neighborhood plans and compared them with satellite images to identify current projects. After this review, we found no conflicts or mismatches between the planned land uses and our planning patterns.

For parcels outside transit buffers with a 15-minute city score of 25 or higher and lower than 30, we designated for 2-3 family housing - small-scale residential buildings designed to accommodate two to three separate households, such as duplexes or triplexes. Using the same step of *Select by Attributes*, we identified parcels for 2-3 family housing in areas outside the TOD Zone with a 25 or higher score.

For parcels outside transit buffers with a 15-minute city score below 25, we designated for single-family units. Using the same step of *Select by Attributes*, we determined parcels outside the TOD Zone with a 15-minute city score under 25. However, we were more cautious when considering single-family housing for these areas. In some cases, we prioritized alternative land uses due to environmental considerations.

Integrate Side Yard Strategies and Environmental Constraints

We implemented recommendations from other departments, such as guidelines for side yards. The data-driven mapping was checked with other departments in municipal government, such as Community Development and Economic Development. We revised the current mapping according to their suggestions. It was determined that we had only three parcels recommended as side yards (Figure 21 & 22).

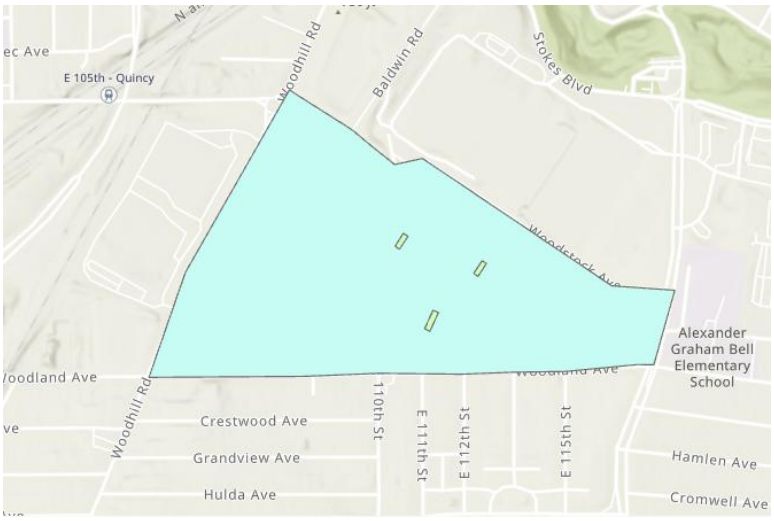
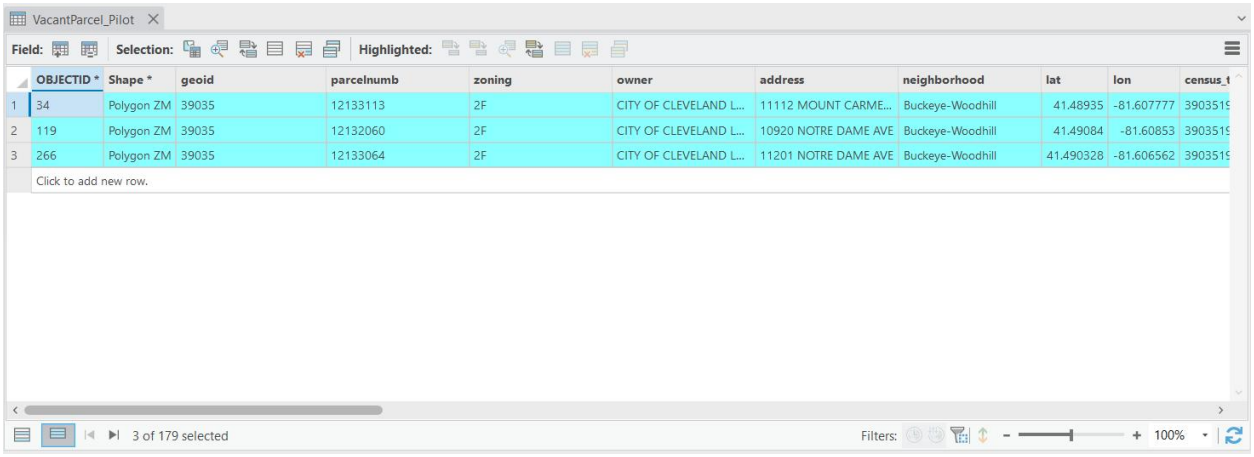


Figure 21 Side Yard Proposal


VacantParcel_Pilot

Field: Selection: Highlighted:

	OBJECTID *	Shape *	geoid	parcelnumb	zoning	owner	address	neighborhood	lat	lon	census_t
1	34	Polygon ZM	39035	12133113	2F	CITY OF CLEVELAND L...	11112 MOUNT CARME...	Buckeye-Woodhill	41.48935	-81.607777	3903519
2	119	Polygon ZM	39035	12132060	2F	CITY OF CLEVELAND L...	10920 NOTRE DAME AVE	Buckeye-Woodhill	41.49084	-81.60853	3903519
3	266	Polygon ZM	39035	12133064	2F	CITY OF CLEVELAND L...	11201 NOTRE DAME AVE	Buckeye-Woodhill	41.490328	-81.606562	3903519

Click to add new row.

3 of 179 selected Filters: 100%

Figure 22 Side Yard Proposal Table

We also considered environmental constraints, ensuring housing units are located at least 300 feet away from highways and in proximity to fire hydrants. Usually, vegetative buffers should be utilized within 500 feet of heavy traffic, but a focus on 300-feet range can also capture most of the pollution caused by heavy transit (Tomson et al., 2021). Implementing Nature-Based Solutions (NBS) can effectively mitigate these issues by filtering air pollutants and reducing noise levels. We created a ¼ mile buffer zone of "ClevelandParks_Buffer" and found the deficiency of amenities of green space. Then, we designated more parcels for NBS when the proposed single-family housing units were located outside the park buffer zone (Figure 23).

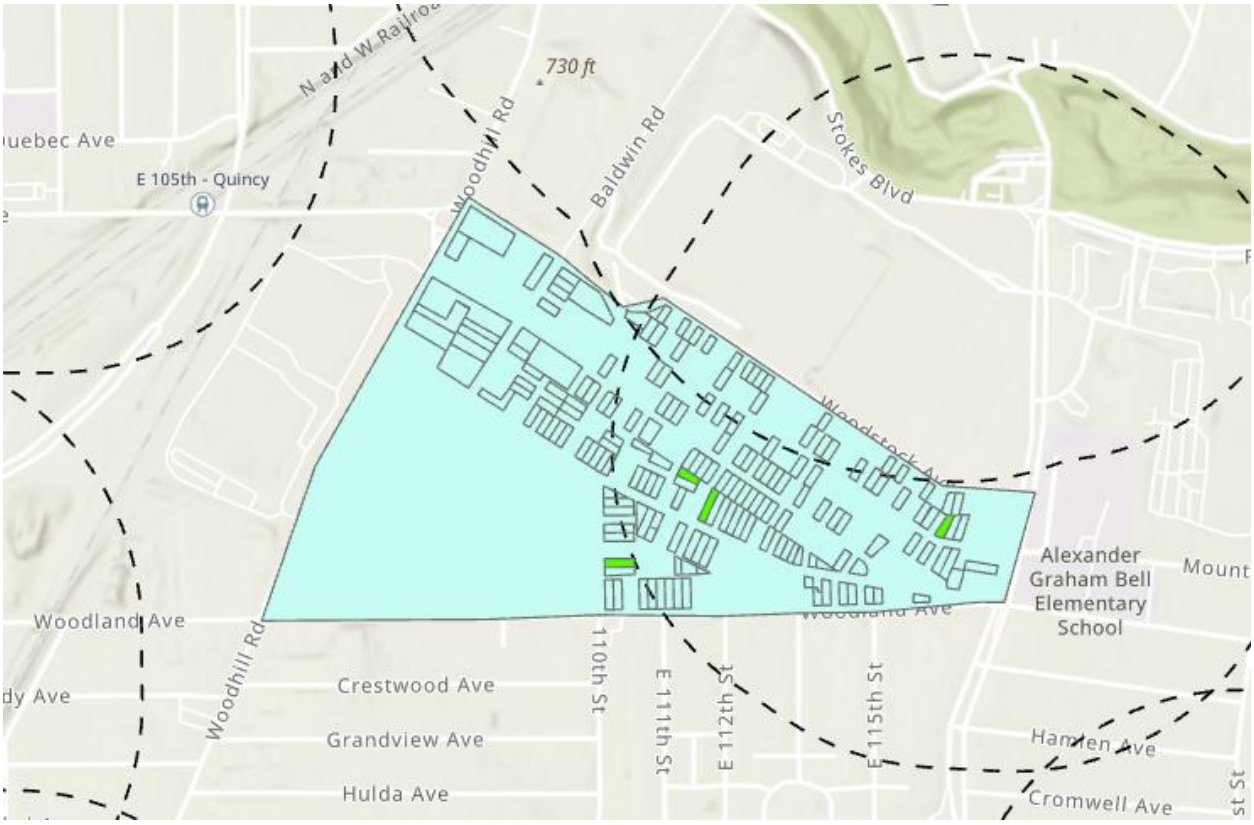


Figure 23 Propose Land Uses given Environmental Constraints

Incorporate Neighborhood Plans and Planner Insights

We integrated recommendations from adopted neighborhood plans and suggestions from neighborhood planners to align designations and land uses accordingly. This process remains internal, involving six neighborhood planners to give recommendations and veto previous land use designations that were solely based on data, incorporating professional insights (*§ 76 City Planning Commission*, n.d.).

Ground-truthing with CDCs and residents and Debrief

The training conducted before ground-truthing was critical, as it ensured that residents had a clear understanding of the city's planning initiatives. Some residents had perspectives that

differed significantly from professional planners' expectations. For example, while professionals had preferred residential areas to be located near public transit, some residents expressed concerns that it could generate nuisances, such as increased noise. Residents also tended to have strong preferences regarding the uses of parking.

Some of the key inputs and critical reflections from the ground-truthing process included residents' deep local knowledge of vacant parcels and their nuanced understanding of land use beyond what is visible on a map. For example, in the pilot ground-truthing process in Slavic Village, some lots that appeared vacant were in fact being informally used—such as being incorporated into adjacent housing plots, repurposed for informal gatherings, or even used as unofficial parking areas. Residents emphasized that certain lots, while technically unoccupied, had become socially or functionally integrated into the surrounding community in ways that aren't captured in official land use data.

CRITICAL REFLECTIONS

In this project, the interplay of dreams, power, data, and partnership was crucial to its development and implementation. The dreams represented the aspirations of policy makers and planning officers who aimed to create a more equitable, sustainable, vibrant Cleveland. These visions, driven by good intentions, sought to revitalize underutilized land, curb urban sprawl, and address long-standing urban challenges, such as vacancy and neighborhood blight. Central to this effort were the city initiatives, which guided the planning process by setting clear goals and priorities. The political will behind these initiatives provided momentum for the project.

These foundational aspirations were crucial in fostering the project, providing a strong framework that generally remained intact despite any later major changes. Mallach (2023) demonstrates a mentality among city officials and policymakers in Rust Belt cities, such as Cleveland, where there is a strong enthusiasm for revitalizing population levels to their historical peaks. This mentality is often accompanied by a keen interest in building housing as a way to stimulate population growth and economic revival. Although community input was incorporated into the process, the overarching structure of the project remained largely top-down, with the city's priorities and vision largely shaping the direction of the planning outcomes.

Power, in this context, was exercised by the city government, which often held technical planning expertise and authority over the project. A key contradiction emerged between the priorities of the city government and organizations like the Western Reserve Land Conservancy (WRLC), which represents the community development corporations (CDCs). While the city government was more interested in housing development and mixed-use spaces, the WRLC and similar groups were focused on ecological resilience through nature-based solutions (NBS). WRLC advocated reservation for parks, green spaces, and ecological preserves to promote environmental sustainability. In contrast, the city's emphasis was on urban density, affordable housing, and revitalizing vacant land through mixed-use development. This power dynamic—where the city government and CDCs' priorities influenced the planning outcomes, particularly in housing development recommendations—led to a fundamental tension in balancing ecological concerns with the need for housing and urban development. While there was room for critical feedback, political support and technical guidance from the city could steer the project toward

development-focused solutions, leaving less room for nature-based solutions that many community groups felt were essential for long-term resilience.

Data played a crucial role in guiding decision-making throughout the planning process, serving as both a valuable reference and a directional tool. Community development corporations (CDCs), such as the Western Reserve Land Conservancy, provided valuable data such as vacant land inventory. The use of the TOD and 15-minute city index helped direct land uses towards areas that could support higher-density, mixed-use developments. These geospatial tools provided a strong foundation for land use prioritization, offering clarity and structure in how decisions were made. However, the use of these GIS data and indices was somewhat limited by the spatial data thresholds set for prioritizing land uses. While these thresholds provided a clear framework for decision-making, they were somewhat rigid and did not fully account for the more nuanced contextual factors that could influence land use. In particular, the data analysis was conducted by planning professionals, which, although necessary for technical rigor, risked reinforcing a technocratic model of decision-making in which expert knowledge dominates. To mitigate this, the data-driven approach was deliberately paired with iterative feedback loops involving community ground-truthing and debrief. This integration helped ensure that while data served as a starting point, final recommendations were grounded in lived experience and community-vetted priorities.

Partnerships were an essential component of this project, bringing together various stakeholders, including the planning commission, neighborhood planners, CDCs, and residents. This collaboration aimed to foster a shared vision for neighborhood revitalization. To address the challenge of vacant properties, land banks are considered as a key tool in facilitating revitalization. They should eventually encourage potential claimants to acquire these vacant properties or promote redevelopment opportunities (Pearsall et al., 2014). In the implementation of our GIS/ground-truthing model, however, the voices of residents, particularly those from underrepresented communities, were sometimes not fully heard. While concept training empowered residents to participate in the ground-truthing process, there were still challenges regarding the depth of their involvement. For instance, access to necessary touchscreen phone devices, the need to empower residents to use “Field Maps”, and the time commitment required from residents all posed barriers. Ensuring that all community members had an equal opportunity

to contribute to decision-making remained a challenge, as it was unlikely that every resident could fully engage. Additionally, the strength of the community network and its relationship with the CDCs greatly influenced the level of resident participation, impacting the model's ability to be broadly adopted and the overall success of the community partnership.

The project timeline of three months was relatively swift, allowing for the integration of these forces within a short period. Yet, despite this rapid progress, there were instances of mismatch in terms of aligning the technical aspects of the data model with the community's needs. While the data-driven approach was largely effective, the differing priorities and perspectives of stakeholders meant that compromises were necessary in some cases. This process reflects the dreams of urban planners, policy makers, and community members who aspire to create a better Cleveland. However, the idealized vision is often shaped by political dynamics, the differing priorities of stakeholders, and other real-world factors.

The limitations of this methodology became evident as the project was brought into the real world. The **high vacancies** in Buckeye-Woodhill, combined with a low median household income and a high unemployment rate, posed significant challenges to the redevelopment process. While the GIS-based decision model suggested potential land uses, there was a risk of overplanning, particularly with the high vacancy rate. Overbuilding in such an area could lead to further blight, as the demand for new housing may not align with the neighborhood's capacity to absorb it. The vacancy rate in Buckeye-Woodhill in 2022 is 19.1%, with many houses either idle or demolished (NEO CANDO (Cleveland and Northeast Ohio Indicator Data), n.d.). In Woodland Hills (former name of Buckeye-Woodhill), population dropped from 6678 to 5625 from 2010 to 2020, with housing units decreasing from 3551 to 3178 during the same period as shown in Figure 18. The Buckeye-Woodhill neighborhood, like its counterparts in the periphery of the city, is facing dual decline in both housing units and population (Census 2020, n.d.). While addressing housing affordability, it is crucial to avoid overbuilding and overplanning, which could lead to further issues of excess housing and limit the potential for more optimized future land uses.

Furthermore, the **quality of infrastructure** in the area also posed a challenge. Many parts of the neighborhood lacked essential amenities like unprotected bike lanes and sufficient green spaces,

which made it less attractive for potential residents or developers. Without addressing these basic infrastructure needs, the attractiveness of the area could remain limited, even if new housing units are introduced. The neighborhood has 527 vacant units (19.1%) that could absorb more population before new construction is needed (NEO CANDO (Cleveland and Northeast Ohio Indicator Data), n.d.). If these vacant houses are not repaired, they could further contribute to the increase in vacant land. In addition, the neighborhood includes underutilized infrastructure such as unprotected bike lanes and streets with a poor tree canopy (Vasquez, 2023). Therefore, investments in infrastructure are essential to ensure the city can draw people back to these neighborhoods.

Many residents in Cleveland face significant **housing affordability issues** due to low-income levels, unemployment that comes along with income instability. Many cannot afford to buy homes, leading to increased demand for rental properties, which drives up rental prices. Moreover, it is challenging to construct new housing here because the median house value is lower than the cost of building a new home. Additionally, the cost of purchasing a new house is around $300,000, which is far beyond the budget of most residents in this neighborhood. While we can build a few new houses, the scale is relatively limited compared to the number of vacant lots. Therefore, the affordability of housing in this area remains a significant concern. Considering the housing trust fund in the neighborhood might alleviate the housing pressure. However, our approach relies on ground-truthing information gathered from residents to prioritize land uses while avoiding displacement. In Buckeye-Woodhill, many people struggle with renting affordable homes instead of purchasing them, which might lead to residents without mortgages paying more property taxes in the future. According to NEO CANDO (2024), owner-occupied housing units account for 28.88%, while renter-occupied units make up 71.12%. Therefore, we also need additional mechanisms, such as housing vouchers and subsidies to alleviate rental pressure, not just providing more decent housing.

There is a need to investigate the age groups, income levels, and rental and ownership ratio of this neighborhood and predict who is going to move in and what density to live in. This information is crucial for making informed decisions about realistic additional housing construction. It is worth mentioning that our research needs CDCs to identify an area with organized community structure for groundwork. However, this process is challenging due to the

uniqueness of the neighborhood and the need for a strong foundation of community cooperation to find residents willing to assist us with ground-truthing.

CONCLUSION

This paper stems from my passion for land use planning and is grounded in the project I participated during my summer internship and field investigations in Cleveland. This project highlights the development of a comprehensive, creative, data-informed framework for prioritizing vacant land reuse that incorporates perspectives from the City, the Council, CDCs, and residents. By applying the principles of Transit-Oriented Development (TOD) and the 15-Minute City Index, the model emphasizes the integration of high-density, mixed-use development to support equitable growth and urban resilience. This approach seeks not only to reverse population decline but also to promote inclusive neighborhoods by encouraging zoning reform, diversifying housing options, and enhancing access to essential services. Through strategic land use planning that balances economic development, affordable housing, and environmental stewardship, this project aims to contribute to a more vibrant and equitable urban fabric. Additionally, the integration of Nature-Based Solutions (NBS) underscores a commitment to sustainability, climate adaptation, and improving community well-being.

However, the project also revealed significant limitations. High vacancy rates, aging infrastructure, economic hardships, and deep-rooted affordability challenges continue to constrain revitalization efforts. The gap between the city's development-driven priorities and community organizations' ecological resilience goals posed fundamental tensions in the planning process. While data and spatial indices provided valuable structure, they sometimes lacked the flexibility needed to capture neighborhood-specific complexities. Furthermore, barriers to full resident participation, including technology access, time commitments, and varying levels of community network strength, limited the broader implementation of ground-truthing.

Looking ahead, Cleveland's future efforts should continue to refine collaborative strategies, enhance data-driven decision-making, and deepen community engagement to ensure planning initiatives remain responsive and inclusive. A critical strength in Cleveland's revitalization landscape lies in its robust network of CDCs, which have long played a pivotal role in advancing neighborhood-based initiatives and facilitating meaningful resident participation. Leveraging the deep-rooted connections and capacities of CDCs is essential for embedding ground-level engagement into planning processes, ensuring that residents have a voice in shaping the future of

their communities. At the same time, Cleveland's relatively progressive city planning environment provides a strong foundation for advancing innovative and equity-focused strategies. The City's maintains an openness to new paradigms, willingness to prioritize mix-uses, public transportation, sustainability, and commitment to addressing long-standing urban sprawl. It is my hope that this project serves as a catalyst for ongoing innovation and partnership, inspiring sustainable and equitable revitalization for Cleveland's communities in the years to come.

REFERENCES

15 Minute City Points of Interest. (n.d.). Retrieved March 12, 2025, from https://data.clevelandohio.gov/maps/17e8378f03114d139e68e6a045fcf748

Allam, Z., Moreno, C., Chabaud, D., & Pratlong, F. (2023). Proximity-Based Planning and the "15-Minute City": A Sustainable Model for the City of the Future. In R. Brinkmann (Ed.), *The Palgrave Handbook of Global Sustainability* (pp. 1523–1542). Springer International Publishing. https://doi.org/10.1007/978-3-031-01949-4_178

Alexander, F. S. (2005). Land Bank Strategies for Renewing Urban Land. Journal of Affordable Housing & Community Development Law, 14(2), 140–169. https://www.jstor.org/stable/25782736

Alexander, F. S. (2011). *Land Banks and Land Banking*.

Basu, M.; Hashimoto, S.; Dasgupta, R. The mediating role of place attachment between nature connectedness and human well-being: Perspectives from Japan. *Sustain. Sci.* 2020, *15*, 849–862.

Bertolini, L. (1999). *Spatial Development Patterns and Public Transport: The Application of an Analytical Model in the Netherlands* (world). https://doi.org/10.1080/02697459915724

Bronin, S. C. (2024). *Key to the City: How Zoning Shapes Our World*. W. W. Norton & Company.

Burkholder, S. The New Ecology of Vacancy: Rethinking Land Use in Shrinking Cities. *Sustainability* 2012, *4*, 1154–1172.

Calthorpe, P. (1993). *The Next American Metropolis: Ecology, Community, and the American Dream*. Princeton Architectural Press.

Census 2020. (n.d.). Retrieved July 8, 2024, from https://planning.clevelandohio.gov/census2020/index.html

City of Cleveland Property Inventory—2023. (2023, July 20). ArcGIS StoryMaps. https://storymaps.arcgis.com/stories/943f26c946994574a8d5f05cecf10a59

Cleveland Planning Commission. (2024, Summer). *Low-Rish Land Use Plan* [Meeting]. Cleveland, OH.

CITY PLANNING | Encyclopedia of Cleveland History | Case Western Reserve University. (2019, May 31). https://case.edu/ech/articles/c/city-planning

Cleveland Form Based Code Project. (n.d.). Retrieved February 27, 2025, from https://planning.clevelandohio.gov/fbc/

Cleveland takes big steps toward Mayor Bibb's vision for a 15-minute city | City of Cleveland Ohio. (n.d.). Retrieved March 12, 2025, from https://www.clevelandohio.gov/news/cleveland-takes-big-steps-toward-mayor-bibbs-vision-15-minute-city

Cleveland-Form-Based-Code-REV.pdf. (n.d.). Retrieved February 27, 2025, from

https://planning.clevelandohio.gov/fbc/assets/Cleveland-Form-Based-Code-REV.pdf

Cleveland's 15-minute city journey. (n.d.). 15-Minute City. Retrieved March 11, 2025, from https://www.15minutecity.com/blog/cleveland

Cleveland Historic Maps. (n.d.). Retrieved August 9, 2024, from https://www.arcgis.com/apps/View/index.html?appid=ddb0ee6134d64de4adaaa3660308abfd

Cleveland's new form-based code may change the look and feel of "The Land." (n.d.). Retrieved March 12, 2025, from https://spectrumnews1.com/oh/columbus/news/2024/05/23/new-zoning-brings-cleveland-closer-to-creating-a-15-minute-city-reality

Croeser, T., Garrard, G., Sharma, R., Ossola, A., & Bekessy, S. (2021). Choosing the right nature-based solutions to meet diverse urban challenges. *Urban Forestry & Urban Greening,* 65, 127337. https://doi.org/10.1016/j.ufug.2021.127337

De Sousa, C. (2005). Policy Performance and Brownfield Redevelopment in Milwaukee, Wisconsin. *The Professional Geographer*, *57*(2), 312–327. https://doi.org/10.1111/j.0033-0124.2005.00480.x

Eanes, F., & Ventura, S. J. (2015). *Inventorying Land Availability and Suitability for Community Gardens in Madison, Wisconsin*.

Elwood, S. (2002). The impacts of GIS use for neighbourhood revitalization in Minneapolis. In *Community Participation and Geographical Information Systems*. CRC Press.

Escobar, F., Hunter, G., Bishop, I., & Zerger, A. (2008). Introduction to GIS. *Department of Geomatics, The University of Melbourne,* Available online at: http://www. sli. unimelb. edu. au/gisweb/(Accessed 02 April 2008).

Faehnle, M., & Tyrväinen, L. (2013). A framework for evaluating and designing collaborative planning. *Land Use Policy*, *34*, 332–341. https://doi.org/10.1016/j.landusepol.2013.04.006

Fedewa, R., & Severn, S. (n.d.). *Planning & Zoning Center at Michigan State University Pardeep Toor Jason Cox Mark Wyckoff, FAICP*.

Form Based Code. (n.d.). Retrieved February 27, 2025, from https://planning.clevelandohio.gov/fbc/cpc.html

Gobster, P.H.; Hadavi, S.; Rigolon, A.; Stewart, W.P. Measuring landscape change, lot by lot: Greening activity in response to a vacant land reuse program. *Landsc. Urban Plan.* 2020, *196*, 103729.

Goldstein, J., Jensen, M., & Reiskin, E. (n.d.). *Urban Vacant Land Redevelopment: Challenges and Progress*.

Gray, M. N. (2022). *Arbitrary Lines: How Zoning Broke the American City and How to Fix It*. Island Press.

Hackworth, J. (2016). Demolition as urban policy in the American Rust Belt. Environment and Planning A: Economy and Space, 48(11), 2201–2222. https://doi.org/10.1177/0308518X16654914

Hollstein, L. (2019). Believing in Cleveland: Managing decline in “the best location in the nation, by J. Mark Souther: Philadelphia, Temple University Press, 2017. *Journal of Urban Affairs*, *41*(2), 264–265. https://doi.org/10.1080/07352166.2018.1483141

Ibrahim, S. M., Ayad, H. M., Turki, E. A., & Saadallah, D. M. (2023). Measuring Transit-Oriented Development (TOD) levels: Prioritize potential areas for TOD in Alexandria, Egypt using GIS-Spatial Multi-Criteria based model. *Alexandria Engineering Journal*, *67*, 241–255. https://doi.org/10.1016/j.aej.2022.12.053

Innes, J. E. (1995). Planning Theory’s Emerging Paradigm: Communicative Action and Interactive Practice. *Journal of Planning Education and Research*, *14*(3), 183–189. https://doi.org/10.1177/0739456X9501400307

Kim, G., Newman, G., & Jiang, B. (2020). Urban regeneration: Community engagement process for vacant land in declining cities. *Cities*, *102*, 102730. https://doi.org/10.1016/j.cities.2020.102730

Kovach, T. (n.d.). *50 Years Ago: A Burning River Ignites the Environmental Movement*. Retrieved February 25, 2025, from https://blog.kao.kendal.org/50-years-ago-a-burning-river-ignites-the-environmental-movement

Kowalski, G. (2024, December 11). CLEVLOT: Demystifying Vacant Land Reuse in Cleveland Neighborhoods. *Western Reserve Land Conservancy*. https://wrlandconservancy.org/clevlot-demystifying-vacant-land-reuse-in-cleveland-neighborhoods/

Lasting Impact of Cleveland’s “Redlined” Neighborhoods. (n.d.). Retrieved March 7, 2025, from https://spectrumnews1.com/oh/columbus/news/2020/06/17/lasting-impact-of-cleveland-s--redlined--neighborhoods

Lepley, M., & Mangiarelli, L. (n.d.). *Exclusionary Zoning in Cuyahoga County*.

Levine, J. (2023). Arbitrary lines: How zoning broke the American city and how to fix it, by M. Nolan Gray: Washington, DC, Island Press, 2022. *Journal of Urban Affairs,* 45(7), 1383–1385. https://doi.org/10.1080/07352166.2022.2145157

lincoln-superuser. (2021, January 12). *Home*. Lincoln Institute of Land Policy. https://www.lincolninst.edu/publications/articles/2021-01-legacy-innovation-how-leaders-cleveland-reimagined-rebuilt-their-city-after-decades-decline/

Liu, L., Zhang, M., & Xu, T. (2020). A conceptual framework and implementation tool for land use planning for corridor transit oriented development. *Cities*, *107*, 102939. https://doi.org/10.1016/j.cities.2020.102939

Mallach, A. (2023). Smaller cities in a shrinking world: learning to thrive without growth. Island Press.

Malczewski, J. (2004). GIS-based land-use suitability analysis: A critical overview. *Progress in Planning*, *62*(1), 3–65. https://doi.org/10.1016/j.progress.2003.09.002

McClintock, N., Cooper, J., & Khandeshi, S. (2013). Assessing the potential contribution of vacant land

to urban vegetable production and consumption in Oakland, California. *Landscape and Urban Planning*, *111*, 46–58. https://doi.org/10.1016/j.landurbplan.2012.12.009

Micklow, A. C., & Warner, M. E. (2014). Not Your Mother's Suburb: Remaking Communities for a More Diverse Population. *The Urban Lawyer*, *46*(4), 729–751.

Morckel, V. (2015). Community gardens or vacant lots? Rethinking the attractiveness and seasonality of green land uses in distressed neighborhoods. *Urban Forestry & Urban Greening*, *14*(3), 714–721. https://doi.org/10.1016/j.ufug.2015.07.001

Moss, M. (2024, April 5). *Transit Oriented Development in Cleveland*. ArcGIS StoryMaps. https://storymaps.arcgis.com/stories/9b1f271d104b4e8f9bc2d19ac03732c0

Murray, D., Quackenbush, M., & Quackenbush, D. M. and M. (2021, July 7). After Industry: Cleveland's Renaissance as the Rust Belt Poster Child. *Midstory*. https://www.midstory.org/after-industry-clevelands-renaissance-as-the-rust-belt-poster-child/

NEO CANDO (Cleveland and Northeast Ohio Indicator Data). (n.d.). Retrieved July 24, 2024, from https://neocando.case.edu/neocando/index.jsphttps://data.clevelandohio.gov/datasets/b2a2da54401a41e78dd71563f01f5273_0/explore?location=41.485498%2C-81.614342%2C14.68

NEOCANDO | *Northeast Ohio Community and Neighborhood Data for Organizing.* (n.d.). Retrieved July 8, 2024, from https://neocando.case.edu/neighborhood-strategy.html

Oprea, M. (n.d.). *Census Data Shows Diverging Population Trends in Cleveland Neighborhoods, With Some Adding Housing Units But Losing Residents*. Cleveland Scene. Retrieved February 27, 2025, from https://www.clevescene.com/news/census-data-shows-diverging-population-trends-in-cleveland-neighborhoods-with-some-adding-housing-units-but-losing-residents-41941372

O'Sullivan, D. autor/a. (c200). *Geographic information analysis*. New Jersey John Wiley and Sons.

Pearsall, H., Lucas, S., & Lenhardt, J. (2014). The contested nature of vacant land in Philadelphia and approaches for resolving competing objectives for redevelopment. *Cities*, *40*, 163–174. https://doi.org/10.1016/j.cities.2013.04.008

Pickles, J. (1995). *Ground Truth: The Social Implications of Geographic Information Systems*. Guilford Press.

Planning Support Systems: A New Perspective on Computer-Aided Planning—Richard E Klosterman, 1997. (n.d.). Retrieved February 27, 2025, from https://journals.sagepub.com/doi/abs/10.1177/0739456X9701700105?casa_token=WeiOCSepfGAAAAA:mt8VrqRixTkbgk3RSj8kjZfSjj6RBoW3rDVp9JuS09bLxawGHGXhg9QTwUFRSeUDTif3NfQPTi3_bQ

Progress, C. for C. (2021). *Tackling Vacancy and Abandonment: Strategies and Impacts After the Great Recession*. Center for Community Progress.

Re-Imagining Cleveland Ideas To Action Resource Book, 2011 1. (n.d.). Retrieved March 13, 2025, from https://cplorg.contentdm.oclc.org/digital/collection/p16014coll33/id/503/

Rigolon, A. A complex landscape of inequity in access to urban parks: A literature review. *Landsc. Urban Plan.* 2016, *153*, 160–169.

Rose, W. G. (1990). *Cleveland: The Making of a City*. Kent State University Press.

Schilling, J., & Logan, J. (2008). Greening the Rust Belt: A Green Infrastructure Model for Right Sizing America's Shrinking Cities. Journal of the American Planning Association, 74(4), 451–466. https://doi.org/10.1080/01944360802354956

Shaheen, M. (2023, June 17). Ubuntu Gathering Place Opens in Buckeye-Woodhill. *Western Reserve Land Conservancy*. https://wrlandconservancy.org/ubuntu-gathering-place-opens-in-buckeye-woodhill/

TOD - Best Practices | RideRTA. (n.d.). Retrieved March 12, 2025, from https://www.riderta.com/tod/bestpractices

Transportation Research Board & National Academies of Sciences, Engineering, and Medicine. (2004). *Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects* (p. 23360). Transportation Research Board. https://doi.org/10.17226/23360

Vasquez, R. E. H., Darine Yusuf, Maritza. (2023, December 10). Buckeye-Woodhill: Framework for a 15-min Neighborhood. ArcGIS StoryMaps. https://storymaps.arcgis.com/stories/d67708eca85b4f42af2e41ebcd802798

Village of Euclid v. Ambler Realty Co., 272 U.S. 365 (1926). (n.d.). Justia Law. Retrieved February 19, 2025, from https://supreme.justia.com/cases/federal/us/272/365/

Visual Cleveland | Decennial Census Data—Cleveland Population Change, 1800-2020. (n.d.). Retrieved February 10, 2025, from https://visual.clevelandhistory.org/census/

Wallerstein, M. (n.d.). *Brownfield Redevelopment and Effects on Community: A Study of the Collinwood Neighborhood in Cleveland Ohio*.

Why the 'Greening' of Vacant Land Is a Smart Long-Term Investment in Cities. (n.d.). Retrieved March 13, 2025, from https://nextcity.org/features/why-the-greening-of-vacant-land-is-a-smart-long-term-investment-in-cities