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ABSTRACT

The lack of access to in-home running water from inadequate plumbing is a critical water insecurity challenge in the U.S. Using the concept of plumbing poverty, this paper investigates why housing policies in Detroit, Michigan, have failed to ensure adequate plumbing and water security for renters using interviews with city employees, community groups, renters, and property managers. We find that unresponsive landlords enabled by historical housing mismanagement and ineffective rental ordinance design and implementation perpetuate inadequate plumbing for Detroit renters. While we identify three tools to address inadequate plumbing, several barriers prevent their use. For renters, barriers include social power dynamics, structural inequalities in the legal system, and a lack of capacity. Meanwhile, the city faces financial, personnel, and knowledge constraints that prevent adequate enforcement. Our findings provide new insight into the connections between historical housing dynamics, policy implementation, and the precarity of landlord-tenant relations in perpetuating water insecurity.

KEYWORDS

Water; housing; rental housing; policy; environmental justice

Introduction

The lack of access to in-home running water for drinking, cooking, sanitation, and personal health due to inadequate plumbing infrastructure is a critical water insecurity challenge in the United States. The notion of “plumbing poverty” was developed as a methodology to explore the uneven spatial distributions of water insecurity and is defined as a “material and infrastructural condition produced by social relations that fundamentally vary through space” (Deitz & Meehan, 2019, p. 1094). In this study, we build on the concepts and methods of plumbing poverty (see [Appendix A, Table A1](#) for definitions of key terms) to investigate how inadequate plumbing has resulted in water insecurity for urban renters in Detroit, Michigan, due to uneven social relations and institutional inequalities.

At the nexus of housing quality and drinking water access, water insecurity due to inadequate plumbing has critical health and equity implications for vulnerable households (Meehan, Jurjevich et al., 2020). Inadequate plumbing can include deteriorated, damaged, or a complete lack of piping that creates low water pressure, leaks, or prevents water from running; a lack of bathroom fixtures such as running toilets, bathtubs, or sinks; and broken kitchen faucets, drains, and sinks. Water insecurity from inadequate plumbing can impact individuals’ mental and physical health due to changes in personal hygiene, disease transmission, poor sanitation, and poor nutrition (Aguilar, 2021; Young et al., 2021), as well as through psychological and social stresses like “heightened worry, anger, frustration, and distress” (Gaber et al., 2021; Young et al., 2021, p. 1063).

In 2019, almost half a million, or 468,497 ($\pm 5,585$ margin of error [MOE]), U.S. households suffered from a lack of complete plumbing facilities—a measure used by the U.S. Census that encompasses several dimensions of inadequate plumbing (USCB, 2019a). Inadequate plumbing in

the U.S. is experienced disproportionately by communities of color, renters, and low-income households (Gasteyer et al., 2016; Meehan, Jurjevich et al., 2020; Wescoat et al., 2007). For example, between 2006 and 2010, Hispanic and Black Americans lacked complete indoor plumbing at a rate almost twice that of white Americans (Gasteyer et al., 2016). During the same period, Native Americans lacked complete indoor plumbing at a rate almost 6.5 times that of white Americans (Gasteyer et al., 2016). Households below the national poverty level experience inadequate plumbing at almost twice the national rate (Wescoat et al., 2007). Exacerbating these inequalities is that water-insecure, low-income people often need to purchase bottled water or use resource-intensive methods to acquire water when plumbing is unavailable (Teodoro et al., 2022; Young et al., 2021). Inadequate plumbing is often understood to be a rural and Tribal struggle in the U.S. since Native American households are much more likely to have incomplete plumbing (Deitz & Meehan, 2019). However, it is also experienced by urban residents. Urban renters, in particular, struggle with inadequate plumbing: in the 50 largest U.S. metros, renters are 1.61 times more likely to lack piped water than homeowners even though there are often regulations in place for rental housing (Meehan, Jurjevich et al., 2020).

While previous studies have provided an understanding of the distributions and consequences of inadequate plumbing, less research has sought to understand why it occurs among highly affected urban populations like renters and what barriers exist to addressing it. However, previous studies have found that renters are particularly vulnerable due, in part, to structural power imbalances with their landlords that affect housing quality and stability (Balzarini & Boyd, 2021; Garboden & Rosen, 2019; Immergluck et al., 2020; Rosen & Garboden, 2022; Travis, 2019). Building on this work, we use a case study of Detroit, Michigan, to identify the institutional and social conditions contributing to inadequate plumbing and its occurrence among renters despite regulatory protections. Our case study provides a deep understanding of the actors and structures shaping the housing-water nexus in Detroit, including property managers, renters, community leaders, government employees, and housing lawyers. We use interview data to understand inadequate plumbing from the positions of each group, both independently and in relation to one another.

We find that renters in Detroit experience inadequate plumbing for three interrelated reasons: (1) historical mismanagement of the housing stock, (2) a lack of effective policy design and implementation by the city, and (3) unresponsive landlords who for various reasons, fail to properly maintain their properties. Several barriers allow inadequate plumbing to occur in Detroit, including power imbalances between renters and landlords, a lack of resources and knowledge to access available tools for renters, and structural features of the legal system that disadvantage renters and inhibit housing improvements. We also find that Detroit has capacity constraints that hinder the implementation of the rental ordinance. Collectively, these conditions produce and perpetuate inadequate plumbing among Detroit renters. Our findings underscore the complex social, infrastructural, and political dynamics that produce and sustain plumbing poverty for urban renters, and we propose policy interventions and further research to help address the issue.

Inadequate plumbing and the links between housing and water insecurity

Water insecurity—determined by the lack of access to adequate, affordable, reliable, or quality water—is closely intertwined with housing insecurity (Jepson et al., 2017). Studies of water insecurity in mobile homes show that those living in mobile home parks are more likely to have unreliable water access and high rates of water shutoffs (Pierce & Gonzalez, 2017; Pierce & Jimenez, 2015; Wescoat et al., 2007). Owners of private mobile home parks contribute to unreliability by directly or indirectly disconnecting water for residents with unpaid rent, despite these being public water systems (Pierce & Gonzalez, 2017). Unhoused communities also struggle with unreliable access to water, sanitation, and hygiene (WaSH) services due to what Meehan et al. (2023) describe as the “dwelling paradox” where state-constructed social and spatial power structures produce water insecurity (Avelar Portillo et al., 2023). Other studies have linked unaffordable water to housing insecurity in cities such as Boston,

Massachusetts, and Detroit, Michigan (Gaber, 2021; Sarango et al., 2023; We the People of Detroit, 2016).

Inadequate plumbing is often a predictor or condition of water and housing insecurity and is experienced unevenly among U.S. households. Previous studies establish inadequate plumbing as disproportionately experienced by renters who are low-income and people of color. Meehan, Jurjevich et al. (2020) find that U.S. households without a piped water connection are primarily in urban areas concentrated in the southern and western U.S. The authors also find that “unplumbed households are more likely to be headed by people of color, earn lower incomes, live in mobile homes, rent their residence, and pay a higher share of their income towards housing costs” (Meehan, Jurjevich et al., 2020, p. 2). Urban renters in the largest U.S. cities are also 1.61 times more likely than homeowners to lack a piped water connection (Meehan, Jurjevich et al., 2020). Deitz and Meehan (2019) similarly find that although experiences of incomplete plumbing vary significantly by geography, it disproportionately affects communities of color, with American Indian or Alaska Native (AIAN) and Black households being 3.7 and 1.2 times more likely to lack complete plumbing, respectively. Using national survey data of small water systems in the U.S., Wescoat et al. (2007) similarly find that “renter, multifamily, and Hispanic households” have higher rates of incomplete indoor plumbing (p. 806). Gasteyer et al. (2016) find that incomplete plumbing is correlated with lower education levels and higher levels of unemployment at the national and county levels, while the highest levels of incomplete plumbing occur among people of color. Lastly, in a study of plumbing access in El Paso, Texas, and Ciudad Juárez in Mexico, McDonald and Grineski (2012) find that a lack of plumbing is associated with having lower education levels and more young children in both cities and with high proportions of renters in El Paso.

Missing from this research is insight into *why* inadequate plumbing occurs and *what* perpetuates it among highly affected subpopulations, including clarification on the “legal, political, and socioeconomic dynamics” at the local level that produce this type of water insecurity (Deitz & Meehan, 2019; Meehan, Jepson et al., 2020, p. 10). The disproportionate experience of renters is significant, given that housing quality standards protect many renters. This study aims to build this understanding by investigating the institutional and social determinants of inadequate plumbing for renters.

The structural vulnerability of renters

Previous scholarship on the institutional and social dynamics of the U.S. rental housing market has shown that power imbalances between renters and landlords and a persistent lack of enforcement of local housing ordinances can lead to low rental housing quality (Garboden & Rosen, 2019; Immergluck et al., 2020). Power imbalances stem from landlords’ position as intermediaries between housing policy and tenants, giving them significant control over policy implementation, often with little oversight (Balzarini & Boyd, 2021; Rosen & Garboden, 2022; Travis, 2019). While standards for rental housing quality are often in place at state and local levels, it is up to landlords to follow such standards and ensure that their properties are safe and habitable. Some landlords do not adhere to these standards despite penalties from city officials.

Small landlords may struggle financially and logistically to maintain their properties. However, larger investor-landlords—those that acquire many properties for low values under LLCs—often use a multitude of tactics to avoid enforcement for neglected property maintenance (Bartram, 2019a; Mallach, 2014; Seymour & Akers, 2021; Travis, 2019). Investor-landlords contribute to property divestment by neglecting properties and allowing them to fall into foreclosure, only to repurchase them for low prices (Dewar et al., 2015). Some landlords purposefully invest in distressed properties and neglect repairs to turn a profit (Mallach, 2010). By under-maintaining rental properties, investor-landlords force renters to live in low-quality housing with related physical and mental health impacts (Evans, 2003; Gold, 2016).

When landlords neglect housing quality standards, local governments play a vital role in enforcing housing quality policies. However, previous research on city regulations shows that proper housing quality enforcement can result in worse outcomes for low-income renters. City inspectors use

discretionary enforcement *more* in low- and moderate-income neighborhoods, writing fewer violations for lower-income landlords to reduce the burden on these landlords or prevent abandonment (Bartram, 2019b; Ross, 1996). Differences in enforcement may also stem from city inspectors' perceptions of deservingness, perceiving low-income landlords as good-intentioned but lacking capacity, and wealthy landlords as profit-motivated (Bartram, 2019b). Additionally, resolved building code inspections are correlated with rent increases that affect vulnerable renters already in precarious positions (Bartram, 2019a). This work underscores that discretion by inspectors can help and harm low-income renters by increasing stability but lowering quality.

Power imbalances between renters and landlords can also result in housing instability, as landlords can evict tenants or constrain their housing choices, and current policies reinforce this power. Large investor-landlords tend to engage in “serial filing” where they file for eviction on a tenant multiple times to collect rent, increase revenue, or threaten and discipline tenants (Garboden & Rosen, 2019; Gomory, 2022; Immergluck et al., 2020; Leung et al., 2021; Raymond et al., 2016, 2018; Seymour & Akers, 2021). While serial filings do not often aim to remove a tenant, they threaten stability. Serial filings are also done inequitably, with Black renters experiencing higher shares of serial filings (Immergluck et al., 2020) and Black neighborhoods having higher eviction rates (Desmond, 2012; Raymond et al., 2018). Landlords can also exercise discretion over whom they rent to—creating unequal access to secure housing (Christensen et al., 2022; Fussell & Harris, 2014; Reosti, 2021).

While these dynamics create uneven power dynamics between renters and landlords, there are tools available to renters to address housing quality and stability. However, many of these tools favor landlords or have barriers for renters. For example, tenants may refrain from making disrepair complaints to the city government because they fear retaliation from their landlords (Local Progress, 2019). Legal tools to address property disrepair in response to rent nonpayment cases or other eviction cases are often biased toward landlords, especially in states that aim to create favorable business environments (Akers & Seymour, 2018; Desmond, 2016; Garboden & Rosen, 2019; Hatch, 2017; Seymour & Akers, 2021). Additionally, some city policies like nuisance and water regulations can increase housing insecurity since landlords attempt to mitigate risk through tenant screenings of qualities they equate with these regulations (Greif, 2018). As a result, landlords hold power over housing quality and stability for tenants despite available tools and regulations.

Our study builds on these significant findings by examining inadequate plumbing in Detroit. We investigate how power dynamics between renters and landlords and local government enforcement strategies and capabilities may contribute to inadequate plumbing for renters. We provide new insights into why rental ordinances fail to protect renters and hold landlords accountable, as water access is typically a core component of local housing codes.

Case study: Detroit, Michigan

As a large, post-industrial Midwestern city, Detroit faces many of the challenges common to the region. Broadly, Detroit is a majority-Black city with an old housing stock, fiscal challenges, a high poverty rate, and difficulties maintaining city infrastructure and services. Here we provide a brief discussion of Detroit's history as it relates to housing policy and water access and affordability issues, drawing on more in-depth histories (Akers & Seymour, 2018; Dewar et al., 2015, 2020; Gaber, 2021; Galster, 2012; Kornberg, 2016; Ponder & Omstedt, 2022; Seymour, 2020; Seymour & Akers, 2021, 2022).

Many of Detroit's current housing challenges can be traced to the early and mid-20th century when the city faced postwar “deindustrialization, globalization, suburbanization, and structural racism” (Seymour & Akers, 2021, p. 42). During this time, migration to the surrounding suburbs pulled people, jobs, resources, and attention away from the city where most of its Black residents remained. In the mid- and late 20th century, housing policies preventing Black homeownership and wealth accumulation via predatory and discriminatory practices contributed to growing inequalities between the predominantly white suburbs and the city (Akers & Seymour, 2018). These dynamics contributed to

further population loss, reducing the city's tax base and resulting in many abandoned and vacant properties (Seymour & Akers, 2022).

Two foreclosure crises in the early 2000s and mid-2010s also catalyzed a decline in homeownership and property values in the city and increased foreclosures and rental properties owned by investor-landlords with poor track records (Akers & Seymour, 2018; Dewar et al., 2015, 2020; Seymour & Akers, 2022). During these crises, unemployment increased, elevating high poverty rates and reducing the city's tax revenue, while losses in state revenue sharing impacted public services (Seymour & Akers, 2022). Many of these issues continue to plague Detroit, particularly the foreclosure crises, which dramatically increased Detroit's renter population and the number of out-of-state investor landlords.

Concurrent with Detroit's foreclosure crises, the Detroit Water and Sewage Department (DWSD)¹ instituted water shutoffs in 2014 for residents with past-due water bills.² Detroit's then-Emergency Manager³ devised the shutoffs to address DWSD's financial insolvency after it declared bankruptcy (Gaber et al., 2021). Prior to beginning service shutoffs, DWSD charged residents large bills to cover past erroneously billed sewer service costs and to cover previous tenants' unpaid bills (ACLU Michigan, n.d.). Water rates in Detroit have increased by 119% since 2014, significantly surpassing typical affordability thresholds⁴ due, in part, to disproportionate cost burdens between the urban and suburban areas (Gaber et al., 2021; Moody et al., 2022; We the People of Detroit, 2016). Between 2014 and 2017, at least 100,000 Detroit households had their water shut off (Ake et al., 2017).

Like Detroit's housing crisis, the water shutoff crisis has roots in racial discrimination, urban/suburban inequalities, housing displacement, predatory housing policies, debt issues, and austerity policies (We the People of Detroit, 2016). There is a strong link between water shutoffs and housing since the city can legally demolish homes without active water service (We the People of Detroit, 2016). Property taxes in Detroit can also include water bill debt, which can lead to tax foreclosure if a resident cannot pay their bill (We the People of Detroit, 2016). According to the *Detroit News*, there were 11,600 tax-foreclosed homes with a combined water bill debt of \$21.5 million at the Wayne County Auction in 2014 (Gaber, 2021; Kurth, 2014).

Several studies have also examined the racial inequality exacerbated by the water shutoff crisis in Detroit. Kornberg (2016) examines DWSD's bankruptcy issues through the conceptualization of "territorial stigma," in which Detroit's suburbs weaponized DWSD's regionalization to justify social inequalities in the city and racial inequalities between urban Detroit and its suburbs. Quizar (2020) similarly finds that the water shutoffs were justified and perpetuated by racist rhetoric against Black Detroiters. These motivations are particularly significant, given that the shutoffs disproportionately affected the city's Black residents and led to social, health, and economic complications (Moody et al., 2022). For example, residents from census blocks that experienced shutoffs were 1.55 times more likely to be diagnosed with a water-associated illness between 2015 and 2016 (Plum et al., 2017). Lastly, Ponder and Omstedt (2022) describe shutoffs in Detroit as racialized "slow violence" inflicted by the consequences of municipal debt and the financial dynamics of U.S. urban governance.

Regulation of rental properties in Detroit

In Detroit, several codes regulate rental housing to ensure habitable properties. The Housing Law of Michigan (MCL 125.401) sets the local requirements for rental codes and requires cities to ensure that all rental properties have a Certificate of Compliance ("certificate") to operate legally (Rental Requirements, n.d.). Detroit also has its own rental ordinance that regulates habitability for one- and two-family rental properties (Rental Requirements, n.d.). Landlords must register their properties with Detroit's Buildings, Safety, Engineering, and Environmental Department (BSEED) to lawfully operate (City of Detroit, 2022). Landlords must update this registration every few years, including paying fines, having an inspection, and obtaining a lead clearance (City of Detroit, 2022; City of Detroit Landlord Guide, 2021).

The city completes rental inspections to ensure compliance. Complaints from residents, observations from a Detroit Building Official, and requests from property owners can all prompt an

Table 1. City of Detroit’s ticket fines for rental property violations (Adapted from the City of Detroit Landlord Guide, 2021).⁹

Violation	First Offense	Second Offense	Third Offense
Failure to register	\$250	\$350	\$500
Failure to obtain a lead clearance (1–2 family properties)	\$500	\$1,000	\$2,000
Failure to obtain a lead clearance (all other properties except buildings with 5+ stories)	\$1,000	\$2,000	\$4,000
Failure to obtain a lead clearance (properties with 5+ stories)	\$2,000	\$4,000	\$8,000
Failure to obtain a Certification of Compliance	\$250	\$500	\$1,000

inspection (City of Detroit, 2022). Inspections require a fee and ensure compliance with the maintenance code (City of Detroit Landlord Guide, 2021). For plumbing, Article XV, Division 4 of the code requires that landlords “provide and maintain facilities, fixtures, and systems for the plumbing and drainage,” with all plumbing fixtures maintained without “leaks or defects” and in a “safe, sanitary, and functional condition” (City of Detroit, 2022). The code also requires that plumbing fixtures supply water without defects and that “bathtubs, kitchen sinks, laundry facilities, lavatories, and showers” supply hot and cold water without contamination. If a plumbing-related issue “endangers the health, safety, or welfare of the occupants,” the city can close the property or cut the water supply off (City of Detroit, 2022).

If a property meets the maintenance requirements, it receives a certificate and can operate. If a landlord does not have a certificate, tenants can put their rent into escrow through BSEED—a tool added to the ordinance in 2017 (City of Detroit, 2022). It is also unlawful for a landlord to evict a renter to avoid rental code compliance (City of Detroit, 2022). The code requires that any violations, called “blight violations,” will result in tickets or delayed issuance of a certificate (City of Detroit, 2022). Table 1 shows the ticket structure for code violations. Tenants can also make complaints to the city to prompt an inspection or make repairs themselves and deduct the costs from their rent (Common Questions about Eviction, 2018). Landlords cannot evict tenants for making a disrepair complaint to the city (Common Questions about Eviction, 2018).

A small number of publicly funded programs help renters address their disrepair needs. In Detroit, the nonprofit Wayne Metropolitan Community Action Agency (Wayne Metro) administers these programs (Ruggiero & Yan, 2022). Regarding water specifically, Wayne Metro administers the Great Lakes Water Authority’s Water Residential Assistance Program (WRAP), which provides low-income homeowners and renters with free water conservation and plumbing repairs up to \$2,000 (Hughes et al., 2021; Ruggiero & Yan, 2022). Wayne Metro also administers the state’s Emergency Plumbing Assistance Program, which addresses water access, toilets, faucets, showers, bathtubs, and laundry tubs (Wayne Metropolitan Community Action Agency, 2021).⁵

Inadequate plumbing experienced by Detroit renters

Detroit has high poverty rates, and in 2019, the city’s median household income was \$30,894 (± 390 MOE; USCB, 2019c). Median household income levels are particularly low for Detroit renters, as homeowners had a median household income of \$41,806 (± 774 MOE) in 2019 compared to \$22,468 (± 618 MOE) for renters (USCB, 2019c). This income disparity leads to large housing burdens, with 53.1% of Detroit renters paying 30% or more of their household income on housing costs in 2019 (USCB, 2019b).⁶ These data highlight the economic vulnerability and immobility of Detroit renters.

We use the U.S. Census measure of “incomplete plumbing,” defined as a housing unit lacking hot and cold running water, a flush toilet, or a bathtub or shower, to evaluate inadequate plumbing in Detroit (Raglin, 2015). Figure 1 shows the spatial distribution of inadequate plumbing in Detroit in 2019 by census tract. In 2019, there were 2,948 (± 343 MOE) Detroit households with inadequate plumbing, of which 1,465 (± 242 MOE) were renter households (USCB, 2019a). While inadequate plumbing affects just a fraction of all Detroit households, these data indicate a need for policy reform on rental housing,



Figure 1. Map showing the percentage of renter households with incomplete plumbing by Census tract in Detroit, Michigan, in 2019. Data Source: Social Explorer & U.S. Census Bureau (2019).

given the health and equity implications for households with inadequate plumbing. There are particularly critical equity implications in Detroit where, in 2021, there was an 8% homeownership gap between the city's Black and white residents, with only 49.7% of Black Detroiters owning their homes compared to 57.9% of white Detroiters (Harding, 2023). Overall, these census data are useful for understanding the plumbing and socioeconomic burdens that renters face, but they do not give a full account of how inadequate plumbing affects Detroit renters; this study aims to fill that gap.

Data collection methods

To understand the institutional and social conditions that contribute to inadequate plumbing for Detroit renters, we conducted interviews with city employees, community stakeholders, renters, and property managers (Schreiber et al., 2020). Our interviews produced rich information and new insights into the multi-dimensional nature of rental plumbing poverty.

Study participants were in four groups: city government, community organizations, renters, and property managers. We contacted interviewees via text message, e-mail, phone call, or participation in community meetings. Wayne Metro helped us access participants for the renter group. A participant pool was created by selecting renters from the clients of Wayne Metro's WRAP and Emergency Plumbing Repair Program who lived in Detroit. We then randomized each program's narrowed client list and randomly selected groups of renters for outreach. In total, Wayne Metro reached out to 166 renters via text on our behalf. Wayne Metro then gave us contact information for the renters who replied, which indicated a response rate of 18.7% (31 renters).⁷ We contacted 20 of these renters who indicated clear interest, and 55% of them completed interviews. We also interviewed an additional renter referred by a community contact, and three other interviewees in other participant groups provided information on themselves or their family and friends in rental housing. Participants in both the renter and property manager groups were mailed \$10 Visa gift cards as compensation.

The interview guide contained two core parts but varied slightly for the different interviewee groups. The first part of the guide touched on the interviewee's experiences with Detroit renters

Table 2. Details on interview participant groups.

Group	Types of Interviewees	Topics Covered	Completion	Length
Detroit City Government	Employees in rental compliance, plumbing, housing policy design and implementation, and water departments	Experience with renters with plumbing issues Implementation of rental policies/ programs Potential barriers to water access for renters	43% of contacts completed interviews	1 to 2 hours
Community Organizations	Members of Detroit organizations focused on housing, water, and plumbing, including housing lawyers and community aid groups	Experience with renters with plumbing issues Experience with city rental policies/ programs Potential barriers to water access for renters	47% of contacts completed interviews	½ to 1 hour
Renters	Renters currently or previously living in Detroit	Rental experiences with plumbing and landlords Knowledge of rights and barriers to using tools Social dynamics with landlords, city officials, and the legal system	55% of contacts completed interviews	20 to 40 minutes
Property Managers	Property managers currently or previously working in Detroit	Tenant relationships Rental inspections and compliance Property maintenance issues and barriers	60% of contacts completed interviews	1 hour

facing plumbing issues, including the type of issue, the effects on the renter, interactions with the renter, and resolution of the issue. The second part of the guide asked about the interviewee's understanding of Detroit rental policies, current policies and practices in place, use of current policies, barriers to implementation, and effective/ineffective components of these practices. [Table 2](#) details where the guide asked unique questions for different participant groups beyond these two core parts.

We completed 32 semi-structured interviews via Zoom or phone call between November 2021 and February 2022. Interviews were conducted remotely due to the COVID-19 pandemic. [Table 2](#) provides information on each group's participant and interview details. After completion, the interviews were transcribed, coded, and analyzed using NVivo. The coding process sought out thematic patterns in the participant groups concerning the research questions. We developed an initial coding structure and approach during the transcription process. Coding was completed using this structure and updated iteratively in response to new themes that emerged during the process. We subsequently inductively analyzed the coding results to extract themes and conclusions from the highly specific experiences of the study participants from their respective positions within the Detroit housing-water nexus.

We acknowledge the positionality of the interviewing author (first author) and how it may have affected data collection. This author holds educational and racial privilege and comes from a large academic institution that could have made interviewees with more historically marginalized identities cautious, selective, or worried about the exploitation of their answers. The latter is especially salient given the history of exploitative research done on communities of color by white researchers. The interviewing author worked individually and with Wayne Metro to build trust, connection, and respect with interviewees to alleviate potential issues.

Results

Why inadequate plumbing occurs in Detroit

Landlord neglect and failure to maintain rental properties are at the core of inadequate plumbing issues for Detroit renters, but there are different reasons for landlord neglect. Our interviewees

Table 3. Frequency of plumbing issues reported by each interviewee group.¹⁰

Group	Types of Plumbing Issues	Frequency
Detroit City Government	Old and deteriorated piping causing secondary issues inclusive of leaks, no access, rust in water, issues restoring water service after shutoff, lead in water, and/or low water pressure	5
	Flooding in basement from sewer backups	2
Community Organizations	Inoperable plumbing fixtures and appliances	2
	Toilet issues inclusive of broken or outdated fixtures, leaking, and/or constant running	5
	Flooding in basement from sewer backups	4
	Water leaks from using appliances, including leaks that cause standing water in the basement	3
	Lack of water access in part or all of the home	3
	Old and deteriorated piping causing secondary issues inclusive of leaks, no access, rust in water, issues restoring water service after shutoff, lead in water, and/or low water pressure	3
Renters	Water bill debt and shutoffs	2
	Inoperable plumbing fixtures and appliances	2
	Water leaks from using appliances, including leaks that cause standing water in the basement	7
	Flooding in basement from sewer backups	7
	Old and deteriorated piping causing secondary issues inclusive of leaks, no access, rust in water, issues restoring water service after shutoff, lead in water, and/or low water pressure	6
	Inoperable plumbing fixtures and appliances	5
	Toilet issues	2
Property Managers	High water bill	2
	Old and deteriorated piping causing secondary issues inclusive of leaks, no access, rust in water, issues restoring water service after shutoff, lead in water, and/or low water pressure	2

provided unique yet intersecting insights into the types of landlords in Detroit and how they have contributed to property neglect, specifically in relation to plumbing. Additionally, our findings illuminate the types of plumbing issues Detroit renters face; Table 3 shows these results. Across all groups, the most common issues include deteriorated pipes, basement flooding, water leaks (including those related to standing water in the basement), inoperable plumbing fixtures and appliances, and toilet issues.

Our results show continuity across interviewee groups around the tendencies of landlords’ motivations and capacities for making repairs according to differences in size and type implicitly or explicitly assigned by interviewees (see Appendix B, Table B1). This allowed us to gather insights into the prominent types of Detroit landlords, their barriers to compliance, and what solutions might best address these barriers. At the same time, some of our interviewees’ descriptions of Detroit landlords transcend a particular type or size of landlord. Because of this, we developed a landlord categorization model (Table 4) that aims to conceptualize these results according to motivation and capacity rather than type or size. In this typology, motivation is the willingness of landlords to make needed repairs, and capacity refers to the informational, technical, and financial resources needed for compliance and maintenance.

Table 4 captures four types of landlords in Detroit. The first type is High-High (high motivation, high capacity); these are the “good actors” who need little intervention beyond a quality ordinance but could benefit from positive incentives such as less frequent inspections with consistent compliance. Next is High-Low (high motivation, low capacity) landlords, who have the greatest potential for change because they are willing to make repairs but lack resources. These landlords need support on rental requirements, technical knowledge, and financial capacity. The third type is Low-High (low motivation, high capacity), and these landlords have the resources to make repairs yet neglect their properties. They need ticketing and legal consequences to affect behavior change. The fourth type is Low-Low (low motivation, low

Table 4. Conceptualization of landlord types by variation in capacity and motivation.

	High Motivation	Low Motivation
High Capacity	Type: Responsive Needs: Rewards or Incentives	Type: Non-responsive Needs: Ticketing
Low Capacity	Type: Non-responsive Needs: Resource Support	Type: Non-responsive Needs: Resource Support and Ticketing

capacity); these landlords require resource support and minimal ticketing. We find that High-Low (hereafter “low-capacity”) and Low-High (hereafter “low-motivation”) landlords likely contribute the most to inadequate plumbing for Detroit renters and have emerged due to mismanagement of the city’s housing stock and have been enabled by poor code design and enforcement.

Low-capacity landlords in Detroit face financial barriers to compliance and responsiveness that have been produced by historical mismanagement of Detroit’s housing stock. The financial barriers to becoming a landlord are low due to Detroit’s drastically low housing prices, partly from foreclosure auctions (Dickson, 2021). However, the city’s housing stock is very old, and many inexpensive homes have costly repair needs that outweigh their purchase price. For example, city employees explained that many landlords get homes from the Wayne County Action for “about five thousand dollars” but that it can take anywhere from \$15,000 to \$30,000 to bring it up to code (Personal interviews, personal communication, November 2, 2021; January 14, 2022).

While it may be possible to be aware of these needs prior to purchase, these landlords have nonetheless acquired rental properties they cannot maintain. Exacerbating this dilemma is that increasing rent to cover costs is often not an option since moderate- or high-income renters will not live in such properties, and accessing additional credit can be challenging (Personal interview, personal communication, November 2, 2021). As a result, financial instability becomes cyclical, where structural conditions of the housing market encourage low-capacity landlords to purchase rental properties that they cannot maintain, leaving renters with neglected properties.

The design and implementation of the city’s rental ordinance also exacerbate the financial barriers of low-capacity landlords and discourage proactive property maintenance. Detroit’s rental code requires extensive and costly health and safety repairs to bring properties up to code. While these requirements are vital to ensure safe and livable properties, this ordinance does not accommodate landlords of different capacities since low- and high-capacity landlords face the same fines (Personal interview, personal communication, November 5, 2021). One interviewee described that landlords could face “up to three rounds” of tickets starting at \$1,000 during the enforcement of Detroit’s revamped rental ordinance in 2018. This interviewee emphasized the expensive ticket structure, particularly for “the small landlords who already have financial challenges” (Personal Interview, personal communication, November 2, 2021).

This type of code enforcement not only prevents low-capacity landlords from making needed repairs but also discourages them from engaging with the city due to fears of incurring fines or other costs by registering their properties (Personal interview, personal communication, November 2, 2021). Some of these landlords also face informational barriers that prevent engagement. They can be unaware of the ordinance and its requirements and exist outside the city’s rental system without regular property inspections (Personal interviews, personal communication, November 2, 2021; November 5, 2021). While our interviewees indicated that the city does provide some informational resources to landlords, they need to be more extensive or widely available (Personal interview, personal communication, November 5, 2021).

Alternatively, low-motivation landlords have very different reasons for being nonresponsive and neglecting their properties. These landlords have the resources needed for compliance but lack the motivation to do so or have competing motivations such as profit or portfolio over-scaling. They may be unmotivated due to a lack of local and personal relationships with their tenants and actual or perceived complications of working with the city (Personal interviews, personal communication, November 2, 2021; January 14, 2022; February 9, 2022; February 14, 2022). These low-motivation landlords, known as “Milker” landlords in Mallach’s (2014) categorization, are driven by the potential for profit and refuse to invest in maintenance while collecting rent. As with low-capacity landlords, the city’s history of housing mismanagement and inexpensive, aging housing stock have contributed to an influx of these landlords in Detroit.

The city’s implementation of its rental ordinance has helped enable the neglect of low-motivation landlords. These landlords use several techniques to evade enforcement and compliance. One technique is to pass properties between LLCs to evade ticketing:

If I write an LLC a ticket, the LLC may just morph into another LLC . . . they just don't even address the ticket, or in six months, they may pass it to another company . . . so you may be working with four or five different LLCs They don't put the money back into the property, and . . . they may not even register the deed. (Personal interview, personal communication, January 14, 2022)

Other techniques include refusing to pay code enforcement tickets and taxes on the property and not registering properties with the city. Some landlords use the former technique to intentionally allow their homes to go into tax foreclosure and then repurchase these same homes for low prices at the auction (Personal interview, personal communication, November 5, 2021). Thus far, the city has yet to take extensive steps to close these loopholes or thwart evasive techniques.

Barriers to addressing inadequate plumbing in Detroit

Renters and Detroit city officials have tools to motivate and incentivize landlords to maintain their properties. Renters can request a rental inspection from the city or defend against their landlords in court. Meanwhile, the city can effectively implement its rental ordinance, commonly known as a “Cadillac ordinance,” that is not producing Cadillac results. Our interviews provided insight into why those tools are not being used or, in other cases, not adequate for improving responsiveness from low-capacity and low-motivation landlords.

First, renters can call the city to request a rental inspection but often choose not to. Some renters hesitate to contact the city due to precarious identities such as immigration status or bad experiences with government institutions (Personal interview, personal communication, January 19, 2022). Other renters do not contact the city because of social and power dynamics with their landlords, a lack of information on tenants' rights, and perceptions of the government as ineffective. The most prominent barrier expressed by our interviewees was that of both positive and negative landlord-tenant power dynamics. Sometimes, this was because the renter and the landlord had a personal relationship through years of tenancy or a friend/family connection. Some renters hesitate to burden their landlords and make repairs themselves or cope rather than involve the city. This situation was particularly true for renters with elderly landlords, as described by this renter:

See the landlord is a woman who's about, she's up in age—80. And just wouldn't take any action on it, you know? So, you know, I just dealt with it, you know. And I didn't want to get her [in] trouble . . . but at the same time, it's not fair to have just the small luxuries—like we have to be able to take a bath, you know? (Personal interview, personal communication, January 28, 2022)

Other interviewees hesitated to call the city about repair issues due to fear of retaliation resulting in adverse treatment or eviction. Bringing the issue to the attention of the city may also require the renter to move if the property is out of compliance—resulting in housing insecurity for these renters (Personal Interview, personal communication, January 14, 2022). Some Detroit renters do not have leases, which can allow for direct retaliation, whether the tenant reported their landlord or not. One inspector expressed frustrations over the inability to control these situations:

When we do finally get them, all they do is kick the tenants out because they don't want to spend the money. Actually, that really tragic case just happened to me and I don't know, I can't help the family you know. (Personal interview, personal communication, January 19, 2022)

These negative power dynamics subject some renters to threats, harassment, and mistreatment from their landlords. These dynamics make the renters who endure them fearful to report or challenge their landlord for fear of exacerbating vulnerable dynamics. Our female interviewees particularly expressed facing harassment or knowing about friends and family that faced harassment. For example, in Detroit, some female renters face significant sexual and verbal harassment from male landlords—a dynamic perpetuated by both landlord-tenant power dynamics and gender power dynamics (Personal interview, personal communication, February 1, 2022).

As a second tool, renters can take their landlords to court or use other legal tools to hold their landlords accountable, such as withholding rent using an escrow account and deducting repair costs from rent payments. If a landlord brings a renter to court for eviction, the renter can argue that their nonpayment is in response to disrepair issues neglected by the landlord (Personal interview, personal communication, February 7, 2022). However, landlords are not required to show whether they have a Certificate of Compliance for their property during eviction cases. As with the tool of calling the city, renters often do not use legal tools due to a lack of knowledge, time, and resources, and structural inequities within the court system that disadvantage renters.

Many renters are unaware of the legal rights they have available to them when faced with unresponsive landlords. For example, while renters can defend in eviction cases with evidence of disrepair and non-responsiveness, many do not have the resources or capacity to learn and use such defenses (Personal interview, personal communication, February 7, 2022). Detroit renters also do not have the right to an attorney, so they must hire an attorney or retain one pro-bono—disadvantaging low-income renters. A Detroit housing lawyer described this disparity as follows:

Landlords are hiring attorneys; some of them have almost house counsel that they use all the time, and management companies—some management companies—have a particular attorney that represents that management company. But yeah, most landlords have representation. Most tenants do not. (Personal interview, personal communication, February 7, 2022)

There are numerous legal aid nonprofits in Detroit where renters can find free legal representation. However, judges are not required to notify renters of pro-bono services, and many of these legal organizations are understaffed, choosing to represent only the most extreme cases (Personal interview, personal communication, February 7, 2022). As a result, landlords hold significant power over their tenants during eviction cases, as many tenants defend themselves in court without knowledge of how to properly use evidence of property disrepair as a defense. With in-person court proceedings, tenants must negotiate time off work, arrange transportation, pay for parking, and face other obstacles to physical access that are particularly burdensome for low-income renters (Personal interview, personal communication, February 7, 2022). With more recent online court options, some renters do not have the technology to access online court and upload proper documents or lack the technical knowledge to access online court (Personal interview, personal communication, February 7, 2022).

Even if tenants win their court case, they may face negative repercussions. Any court proceeding, whether a case dismissal or a case ruled in favor of the tenant, stays on a renter's legal record. This can negatively impact a renter's ability to secure housing since eviction court records may disqualify tenants or dissuade future landlords from renting to them (Personal interview, personal communication, February 7, 2022). These records may also affect a renter's credit score. Meanwhile, landlords face no eviction records that negatively affect their property rentals.

Resolving rental maintenance issues in court or through tenant-initiated inspections would be less critical if the city could implement its rental ordinance more effectively. Currently, the city's significant financial, personnel, and information capacity limitations are preventing full policy enforcement. This lack of resources, combined with the constraints of low-capacity landlords, inhibits property maintenance and encourages divestment in the housing stock. Some community organizations in Detroit have property repair programs to help fill this gap, but they face their own constraints. For example, landlords must sign off on any repairs made through these programs, leaving renters vulnerable to the willingness of their landlords (Personal interview, personal communication, November 23, 2021).

With these capacity constraints, managing the city's rental stock and unique landlord landscape prevents effective implementation. With so many rental properties in the city, it is difficult for the existing staff to manage and improve property data to adequately enforce the code for all properties (Personal interview, personal communication, November 5, 2021). For example, one respondent indicated that a case-by-case management technique for landlord compliance was effective in the past, but the city does not have the staff capacity to restart such a program (Personal interview,

personal communication, November 2, 2021). Additionally, without a history of strong code enforcement, Detroit must locate and register all the rental properties they previously neglected to track. Our interview respondents indicated there may be as many as 80,000 rental properties in Detroit, yet only about 5,000 are registered (Personal interview, personal communication, November 5, 2021). Integrating so many properties into their rental database in a short amount of time after decades of little enforcement puts significant stress on the city in terms of financial and staff capacity.

When the city began enforcing its new rental code in 2017, it did so without fully understanding the rental landscape, such as the types of landlords, their financial capacities, and how to target the “bad” actors. Without this context, enforcement has been done too evenly, without adjustment to the needs of different landlords. This has led to ineffective enforcement of property compliance, as evidenced by the small percentage of registered properties and high disrepair levels (Erb-Downward & Merchant, 2020; Personal interview, personal communication, November 5, 2021). If the city implements context-driven enforcement, it could effectively direct ticketing toward low-motivation landlords while providing support and case management to low-capacity landlords. Detroit is currently completing studies to understand the rental landscape to improve code design and implementation (Personal interview, personal communication, November 2, 2021).

Discussion

Access to reliable, safe, adequate, or affordable water is a persistent challenge for many U.S. communities. In this study, we investigate how Detroit’s rental housing market conditions, policies, and practices lay the foundations for inadequate plumbing for renters. We build on emergent scholarship around the underlying social and spatial constructions of residential plumbing issues and larger bodies of research on the links between housing and water insecurity, renter vulnerabilities, and housing policy by examining *why* inadequate plumbing exists and *what* perpetuates it. Our findings highlight the critical connections between historical housing dynamics, local policy implementation, and uneven power dynamics between landlords and renters in Detroit that produce plumbing poverty and provide broader insights for housing and water policy scholarship.

Previous research has identified renters as a critical subpopulation disproportionately experiencing water insecurity due to inadequate plumbing (McDonald & Grineski, 2012; Meehan, Jurjevich et al., 2020; Wescoat et al., 2007). Our research confirms and builds on this as we reveal how the institutions, policies, and tools to protect renters from inadequate plumbing infrastructure are failing. While municipal policies intend to prevent disrepair, Detroit has historically lacked the financial capacity and staff to implement policies effectively, landlords are often unresponsive to code requirements and renters, and the tools available to renters and the city have been ineffective. These findings add to the literature on housing and water precarity by identifying unreliability challenges for renters and building on the role of landlords as policy intermediaries with control of water access (Pierce & Gonzalez, 2017; Pierce & Jimenez, 2015).

We introduce a landlord typology based on our findings in Detroit with the goal of refining policy intervention strategies to address variations in landlord motivation and capacity. Using this typology, we discuss how “low-capacity” and “low-motivation” landlords likely contribute the most to inadequate plumbing in Detroit. This typology adds to those developed in other studies, particularly the “distressed property investor typology” from Mallach (2010, 2014). The characterization of “low-motivation landlords” in our model further grounds the “Milker” landlord from Mallach (2010, 2014), as we show how these landlords increase profits by evading code enforcement, which contributes to inadequate plumbing. Our model points to solutions cities can use for these landlords, such as targeted enforcement facilitated by better data and tickets that dissuade neglect. Our typology also clarifies that there are more than just “bad actor” landlords. Instead, conceptualizing landlords by motivation and capacity gives a nuanced understanding of how landlords contribute to neglect by identifying how well-intentioned landlords can contribute to social and material inequalities like inadequate plumbing.

Our findings on the major types of inadequate plumbing in Detroit connect water insecurity for renters and the Detroit water shutoff crisis. The U.S. Census measure of incomplete plumbing used by this study and others to evaluate inadequate plumbing (e.g., Deitz & Meehan, 2019) does not explicitly include water service disconnection. However, old and deteriorated plumbing is pervasive in Detroit, and these conditions make it difficult or impossible to reconnect households after a shutoff due to the stress of sitting water on aging pipes. Thus, although shutoffs are not directly a plumbing issue, they can cause water insecurity with deteriorating pipes. Additionally, many Detroit households that experienced shutoffs had high water bills because of old plumbing that was leaking or otherwise inefficient. Many of this study's participants cited themselves or others as having plumbing leakage, water debt, and shutoff issues. In this way, inadequate plumbing—in the form of missing, leaking, or inefficient piping—led to high water bills for many Detroiters and subsequent service shutoffs.

This study also contributes to a deeper understanding of renter vulnerability. Existing literature has highlighted how uneven power dynamics between renters and landlords (Balzarini & Boyd, 2021; Garboden & Rosen, 2019; Immergluck et al., 2020; Rosen & Garboden, 2022) and the profit-seeking tactics of landlords (Gomory, 2022; Raymond et al., 2018; Seymour & Akers, 2021) have contributed to the social and economic vulnerability of renters. We find that renters are also vulnerable to water insecurity from inadequate plumbing due to power dynamics with their landlords and within the legal system. These dynamics prevent renters from holding their landlords accountable or using legal tools for fear of retaliation or burdening their landlords. We also highlight the role of local governments in perpetuating uneven power dynamics and contributing to plumbing infrastructure issues, building on the work of Bartram (2019a) and Greif (2018) on the negative impact of good-intentioned regulations. In Detroit, the city's financial, personnel, and knowledge constraints prevent thoughtful ordinance enforcement that engages landlords on compliance and adequately supports tenants.

Previous research has identified legal practices and policies that perpetuate serial eviction filings by large investor landlords (Gold, 2016; Hatch, 2017; Immergluck et al., 2020; Leung et al., 2021). We show intimate connections between plumbing issues and eviction dynamics and injustices by identifying several structural inequalities faced by renters in eviction cases stemming from power imbalances; for example, disparities in the negative repercussions faced by tenants and landlords in eviction cases that enable serial filings by low-motivation landlords. Additionally, we find that renters face informational and resource constraints that disadvantage them in court. These findings provide connections between dynamics of renter vulnerability, eviction, and water insecurity from inadequate plumbing that have thus far been unexplored.

Finally, city inspectors and community organizations are key intermediaries in the housing-water nexus. Bartram (2019a, 2019b) and Ross (1996) show that inspectors can increase housing stability but decrease quality for renters by writing fewer tickets for low-income landlords than wealthy landlords. In Detroit, we also find that inspectors play a unique role in housing quality, functioning as quasi-intermediaries who are both trusted community resources and government agents. These inspectors “humanize” the rental code and consider social context and identities during enforcement while providing dispute resolution, distributing information, and using discretionary enforcement. Still, there are limitations to how much inspectors can improve property compliance, including language and cultural barriers, technology barriers, lack of cooperation, code loopholes allowing for ownership evasion, and more. Meanwhile, organizations providing housing and water assistance programs and legal representation help fill a resource gap for renters struggling with inadequate plumbing.

Conclusion

This study answers calls to explore the production of plumbing poverty in specific locales with a focus on the role of governmental institutions and related political, legal, and socioeconomic dynamics (Deitz & Meehan, 2019; Meehan, Jepson et al., 2020). Our examination of the complex and unequal relationships between tenants, city government, legal institutions, and community organizations in Detroit provides insight into how housing policies, practices, and tools fail to protect against inadequate plumbing and

contribute to water insecurity for urban renters. We provide connections between the current failure of these local policy protections and the racialized spatial and socioeconomic history of Detroit that has crafted the city's present-day geography and shaped its rental housing market.

Our findings ultimately show that the social, political, and spatial conditions and histories embedded in local housing policy produce plumbing poverty. Addressing water insecurity due to inadequate plumbing therefore requires attention to these conditions and histories. The failure of local renter protection ordinances not only threatens housing stability and quality but also causes water insecurity. With growing attention to water equity and access in the U.S. and increasing federal funding for these goals, robust and equitable solutions must contend with the fact that drinking water access is an intersectoral issue deeply connected to housing insecurity challenges—specifically to the precarity of rental housing. Water security issues do not exist in a technical silo; they are the outcome of deep social and political processes and longstanding spatial histories at the housing-water nexus.

This study's findings in Detroit illuminate three major lessons for policymakers and advocates in other weak urban housing markets. First, local leaders should deeply understand their city's rental landscape and focus on forming connections with landlords and tenants before implementing an ordinance. Our findings show important variations not just in landlords' intention and ability to make repairs but also in renters' capacity to deal with inadequate plumbing and their perspectives on useful solutions. Policy interventions must respond to this variability, and a typology such as ours can help ensure effective solutions are used for different landlord types. Second, leaders need to place greater emphasis on social and power dynamics between landlords, tenants, local government, and the legal system that may hinder enforcement or reduce renters' use of tools. Our findings show that even well-intentioned tools and housing policies can fail to hold landlords accountable; local policymakers should ensure they are not standing up policies that maintain the status quo for vulnerable renters. Third, community organizations provide additional capacity and should be supported to expand programs for renters with plumbing issues. Local policymakers should build trusting relationships with community organizations that will help them engage with their communities to understand what policy barriers are arising in practice. However, community organizations must maintain independence as intermediaries with which residents can build trusting relationships outside government institutions.

These findings on the production of plumbing poverty at the local scale are valuable for formulating and implementing rental housing policies that support water security. However, as the study of plumbing poverty and the housing-water nexus are emergent areas of study, further research is needed. Several of our findings point to areas in need of further investigation, including how agency and capacity vary among low-income renters; how "high-high" landlords service the most vulnerable renters; and the extent to which the motivations of different stakeholders, such as city government, perpetuate or reverse inadequate plumbing issues. The use of survey methods for a broader set of cities could quantitatively gauge renters' understanding and use of available policy and legal tools across different localities and policy environments. This would allow for fruitful comparisons between cities on the efficacy of different policy tools and implementation approaches. Additionally, this study focused on local housing policies and practices without equal attention to the role of drinking water policy. Further research is needed at the intersection of these two policy domains to understand how they interact to (re)produce plumbing poverty. Such research can support tangible changes for communities experiencing plumbing issues and related water insecurity.

Notes

1. The DWSD is now part of the broader regional water entity, the Great Lakes Water Authority (GLWA).
2. Detroit renters can either pay their landlord directly for water (with the bill in the landlord's name), or they can have the water account transferred to their name through a Landlord-Tenant Agreement (City of Detroit, *n.d.*).
3. Michigan law (Act 436 of 2012) allows the governor to appoint an unelected "emergency manager" to take the place and authority of the local government in cities with a financial emergency (Michigan Legislature, 2012).

4. We the People of Detroit (2016) notes that the EPA advises that water and sewage service costs should not be more than 2.5% of family income. In Detroit, this threshold is often over 10% for low-income residents.
5. As of July 2023, this program needs additional funding to provide services.
6. 73,806 ($\pm 1,786$ MOE) renter households had this cost burden.
7. This text message outreach had a low response rate but was the outreach method preferred by Wayne Metro, our community partner for our renter interviewees.
8. The “renter” interviewee group is not included because this group’s insights focused more on how their landlord’s actions affected them or shaped their perceptions. Any renter perceptions of landlord capacity and motivation are captured in the “Barriers to addressing inadequate plumbing in Detroit” section.
9. This table does not include the prices for emergency rental tickets, which are more expensive.
10. Types of plumbing issues that only had a frequency of one were not included in the table.

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No potential conflict of interest was reported by the author(s).

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Appendix A.

Table A1. Definitions of key terms.

Term	Definition
Plumbing poverty	We use the definition of plumbing poverty originally developed by Deitz and Meehan (2019): “Plumbing poverty is understood in a dual sense: first, as a material and infrastructural condition produced by social relations that fundamentally vary through space and, second, as a methodology that operationalizes the spatial exploration of social inequality” (p. 1094).
Inadequate plumbing	In the context of water access, we use the term inadequate plumbing to collectively refer to any plumbing conditions that reduce or prevent access to water. This can include but is not limited to deteriorated pipes, damaged pipes, or a complete lack of piping that creates low water pressure, leaks, or prevents water from running; a lack of bathroom fixtures such as running toilets, bathtubs, or sinks; and broken kitchen faucets, drains, and sinks. In this study, inadequate plumbing is representative of the material and infrastructural conditions of plumbing poverty.
Water insecurity	We use the definition of water security from Jepson et al. (2017) to define water insecurity. Jepson et al. (2017) define water security “as the ability to access and benefit from affordable, adequate, reliable, and safe water for wellbeing and a healthy life” (p. 3). Water insecurity occurs when one of the tenets of water security is inaccessible.
Housing insecurity	We use a broad definition of housing insecurity from the Urban Institute, which defines housing insecurity as including “homelessness; housing cost burden; residential instability; evictions and other forced moves; living with family or friends to share housing costs (doubling up); overcrowding; living in substandard, poor quality housing; or living in neighborhoods that are unsafe and lack access to transportation, jobs, quality schools, and other critical amenities” (Leopold et al., 2016, p. 1).



Appendix B.

Table B1. Summary of findings on landlord types by interviewee group.⁸

Group	Attributed Size/Type of Landlord	Types of Landlord Motivation Discussed		Types of Landlord Capacity Discussed	
		Positive or empathetic qualities	Negative or disapproving qualities	Positive or empathetic qualities	Negative or disapproving qualities
Detroit City Government	Smaller Few properties Lower income Fewer resources	<p><i>Wants or intends to</i> comply but lacks financial capacity</p> <p>More cooperative or responsive but need more personal attention</p> <p>Good-intentioned due to personal relationships</p> <p>Some use rentals as supplemental income</p> <p>Some can be responsive</p>	<p>Some never do repairs because they are "content" with their monthly rent income</p>	<p>May not understand the rental ordinance or has other knowledge and technology barriers</p> <p>Lack economies of scale and thus struggle to comply due to lack of financial resources</p>	<p>Some of these landlords don't do repairs</p>
	Corporate Bigger LLCs Higher income Greater resources		Operate on a "buy and sell" model	They have more resources to invest in property repairs	Some decide not to maintain properties because of their "buy and sell" model
			Intentionally obscure ownership to avoid resident contact about repair issues	Have financial resources and use them to take care of their properties	Use their financial resources to increase profits, rather than to make repairs
			Motivated purely by profit rather than relationships		May struggle due to abrupt enforcement measures in 2017
			They can play the game and use their money to beat the system		
			Many are out-of-state and lack local connection		
	No attributed size or type	Majority of landlords do not try to take advantage of people	There are landlords that try to take advantage of tenants no matter their size/type	N/A	Have had disrepair issues with landlords of all sizes/types

(Continued)



Table B1. (Continued).

Group	Attributed Size/Type of Landlord	Types of Landlord Motivation Discussed		Types of Landlord Capacity Discussed	
		Positive or empathetic qualities	Negative or disapproving qualities	Positive or empathetic qualities	Negative or disapproving qualities
Community Organizations	Smaller Few properties Lower income Fewer resources	More cooperative Some aren't landlords to turn a profit, but for other reasons Some rent to stabilize and improve their neighborhoods, but this doesn't always make them money	Some who are renting to family or friends are oblivious to disrepair issues	Face financial barriers, including getting in over their heads with costs of property upkeep since there is major underinvestment and repairs are too expensive for low-rent areas Face technology barriers Have a lack of experience and face knowledge barriers, including having greater difficulty knowing where to find and get good contractors	N/A
	Corporate Bigger LLCs Higher income Greater resources	N/A	Care about reputation and don't want to be labeled a "slumlord" if they own lots of properties Tend to have company attorneys and go to court for several tenants with the same types of issues There are some big landlords that are "slumlords" wanting to make money	Some management companies try to keep properties in good repair but hire contractors who do surface repairs or do them incorrectly	Some are here to only turn a profit which can only be done if they are not investing their profits in property repair
	No attributed size or type	Some landlords want to make a difference and try to do the compliance and legal processes correctly Some landlords face financial issues for upkeep but are different from those that intentionally prevent upkeep	Don't want to be labeled a "slumlord" if they use repair assistance programs Bought properties cheaply, did a quick renovation, and rented it	N/A	N/A

(Continued)



Table B1. (Continued).

Group	Attributed Size/Type of Landlord	Types of Landlord Motivation Discussed		Types of Landlord Capacity Discussed	
		Positive or empathetic qualities	Negative or disapproving qualities	Positive or empathetic qualities	Negative or disapproving qualities
Community Organizations		Some landlords have good intentions, but face financial issues due to the high levels of underinvestment in Detroit	Some hire handymen who do incorrect repairs either due to apathy or unwillingness to commit to fixes Some are oblivious to issues if their tenants don't say anything Lots of egregious landlords that make money by neglecting properties Some intentionally don't keep their properties in good repair Out-of-town landlords are difficult to reach and sometimes just collect rent without making repairs		
Property Managers	Smaller Few properties Lower income Fewer resources	N/A	N/A	Tend to be farther behind on property maintenance Ordinance is financially demanding and makes it hard to keep up with costs	N/A
	Corporate Bigger LLCs Higher income Greater resources	N/A	Out-of-state landlords buy homes in Detroit because they are cheap Out-of-state landlords can be bad at keeping up their properties because they can't manage from a distance Some have told managers that they refuse to invest in their properties appealing because of no rent control Some don't want to fix issues or do anything for their properties	N/A	N/A
	No attributed size or type	There are good and bad intended landlords and sometimes the good landlords get lumped in with the "slumlords"		Prior to the ordinance enforcement, much of property disrepair was due to lack of knowledge of the ordinance and its requirements After ordinance enforcement, compliance is a difficult financial issue	Bad landlords and "slumlords" have made the compliance process more difficult for good players