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The Contributions of Physical Infrastructure to Environmental Health Disparities: Housing, Transportation, and Water

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The physical infrastructure is the most basic and at the same time most varied foundation that makes living and modern social structures possible. Without a functioning, protective, and equitable infrastructure, our very survival as individuals and as a community would not be possible. Much of our existing environmental health apparatus is aimed at protecting aspects of the physical infrastructure (sometimes called the "shared commons"), with only secondary attention to solving environmental health disparities. Historically, the legal structure for the environmental movement in the United States stands on two fundamental principles of English Common Law: "Shared Commons" and "The Polluter Pays." "Shared Commons" is derived from medieval practice governing community use of a public resource. In short, while everyone's cattle may graze on the common green (a key component of the physical infrastructure of its day), nobody's cattle may overgraze the resource and deprive others of its use. In its current legal application, this principle means that the community may act to protect its interest if private activity deprives the public of its right and reliance on a shared resource—e.g., breathable air—or, as explored in this paper, housing, transportation, and water. The "Polluter Pays" principle holds that it is the originator of the pollution, not the injured public, who bears responsibility for the cost of its control.

Contrast this scenario with the aspects of the physical infrastructure we consider in this paper: housing, transportation, and water. For these three, there is not a consistent perceived "shared commons" for which the public feels a communal benefit and responsibility. Even the language is myopic—we refer to a housing *unit*, with the connotation that it is small and insignificant. Small communities and individual drinking water wells are almost entirely unregulated, creating environmental health disparities. And, transportation historically has meant building more freeways without interconnecting neighborhoods, thus creating neighborhoods that are cut off, ill served, or both. For these systems, there may not be a "polluter" that can be identified easily and tasked with payment for remediation.

We have selected three forms of physical infrastructure, one to represent the individual level (housing), another to represent the community level (transportation), and a third that includes both (water), while at the same time recognizing the significant overlap among them all. We have reviewed the literature on the individual and community factors that influence environmental health disparities, either through direct causal pathways or through more indirect distal and proximate pathways. We also have examined the evidence that interventions, particularly in the cases of childhood lead poisoning prevention, traffic calming and rerouting, and establishment of community water systems, can promote the environmental health of the general population *and* at the same time reduce disparities. We also have identified a number of research activities and methodological improvements that are needed, and we close with some conclusions on how scientific evidence on disparities in physical infrastructure can be used to bring environmental justice (EJ) considerations into policy deliberations.

For housing infrastructure, this review shows that racial and ethnic disparities in housing with both severe and moderate physical problems are large and have existed for decades. In contrast, other data demonstrate that when resources are properly targeted and when interventions have been proven effective (as has been the case in childhood lead poisoning prevention from lead-based paint hazards in housing), it is possible to greatly reduce disparities in housing-related health hazards. These two contrasting outcomes are examples of the evidence that housing disparities are pronounced, but effective interventions exist that

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can reduce them. This has enormous implications for how the EJ movement chooses to characterize social determinants of health, particularly in resolving long-standing housing-related health disparities.

For transportation infrastructure, this paper presents available evidence for five pathways through which transportation system infrastructure may cause disproportionate environmental or health impacts on vulnerable populations. Most directly, infrastructure can displace residents and permanently damage community structure and integrity. Second, both the construction and operation of infrastructure can impair (or benefit) walkability and livability. Third, use of motor vehicles on roadways and rail facilities generates air pollution, noise, and pedestrian hazards, disproportionately affecting residents living adjacent to these facilities. Fourth, preferential investments in auto-centered transport have generated a transit-dependent subclass that has substantial barriers to access. Finally, transportation systems facilitate ethnic- and class-based segregation, contributing to the reproduction of environmental injustice.

For water infrastructure, there is clear evidence that there are many cases where low-income, minority communities that rely on individual or shared water systems face risks from contaminants in their drinking water. These include Tribal communities, residents of border *colonias*, migrant farm workers, and communities in other rural areas. In each of these cases, there are efforts at the local, state, and/or federal level to address the problems, even though these agencies have no legislatively mandated regulatory role, and these efforts have involved the affected communities. Examining disparities involves by its nature a comparison of individuals or communities. The majority of evidence comes from the case studies of communities with unregulated water systems. The comparison is an implicit one, comparing these unregulated systems to fully compliant community water systems. Very few studies compare infrastructure between individuals or communities of different socioeconomic status, and these studies have focused on water quality as the outcome. Improving our understanding of disparities associated with water infrastructure will depend on better data, especially geo-referenced data on service area boundaries to link each water system to the individuals served.

Overall, there is no unified research agenda for physical infrastructure disparity research in the United States, although there have been recent advances in this area. The absence of a “home” for housing, transportation, and water quality health research, and research on health and the physical infrastructure generally within the National Institutes of Health, the U.S. Environmental Protection Agency, and other research agencies is noteworthy.

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