United States
Environmental Protection
Agency

Development, Community,
and Environment Division (1808)
Washington, DC 20460

EPA 231-R-01-002
January 2001

Our Built and Natural Environments

A Technical Review of the Interactions between Land Use, Transportation, and Environmental Quality

Acknowledgements

This document has been peer reviewed. EPA acknowledges the helpful comments of Chester Arnold and James Gibbon, University of Connecticut; Robert Cervero, University of California at Berkeley; Susan Handy, University of Texas; Robert Johnston, University of California at Davis; and Peter Meyer, University of Louisville.

Final document produced under EPA contract 68-W-99-054 for the Development, Community, and Environment Division, US EPA Office of Policy, Economics, and Innovation, by ICF Consulting. EPA staff members Geoffrey Anderson and Mary Kay Santore managed this project.

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Executive Summary

In recent years interest has grown in Smart Growth as a mechanism for improving environmental quality. In *Our Built and Natural Environments*, the U.S. Environmental Protection Agency (EPA) summarizes technical research on the relationship between the built and natural environments, as well as current understanding of the role of development patterns, urban design, and transportation in improving environmental quality. *Our Built and Natural Environments* is designed as a technical reference for analysts in state and local governments, academics, and people studying the implications of development on the natural environment.

The built environment has direct and indirect effects on the natural environment. Urban form directly affects habitat, ecosystems, endangered species, and water quality through land consumption, habitat fragmentation, and replacement of natural cover with impervious surfaces. Development patterns and practices also indirectly affect environmental quality since urban form influences the travel decisions that people make. Certain patterns of development encourage increased use of motor vehicles, which is associated with growth in emissions of air pollutants and the greenhouse gases that contribute to global climate change. Air pollution and climate change, in turn, can adversely affect water quality and habitat.

Our Built and Natural Environments first examines trends in land use and their impacts. It then explores how various development patterns and practices can minimize environmental damage.

Land Use: Trends and Environmental Impacts

Trends

Development patterns have changed dramatically over the past century. In the early 1900s, urban areas tended to be compact, with a strong central business district and industrial facilities serving as large employment centers. Communities tended to be walkable and contained a mix of houses and convenience services such as shops. Today's metropolitan areas extend over large areas and employment is frequently widely scattered. People must rely on automobiles for access to jobs and services, as residential and commercial areas are separated, and the pedestrian environment is increasingly inhospitable.

In many regions, urbanized areas have expanded dramatically. Urbanized land area in the United States has quadrupled since 1954. From 1992 to 1997, the national rate of development more than doubled to 3 million acres per year. In most large metropolitan areas, urban land area rose more than twice as fast as population did between 1950 and 1990. The reasons for these dramatic changes in urban form are numerous, including income increases, living style preferences, and public policy on transportation investment, housing, and taxes that have facilitated these trends.

Environmental Impacts

Direct environmental impacts of current development patterns include habitat loss and fragmentation, and degradation of water resources and water quality. Building on undeveloped land destroys and fragments habitat and thus displaces or eliminates wildlife communities. The construction of impervious surfaces such as roads and rooftops leads to the degradation of water

quality by increasing runoff volume, altering regular stream flow and watershed hydrology, reducing groundwater recharge, and increasing stream sedimentation and water acidity. A 1-acre parking lot produces a runoff volume almost 16 times as large as the runoff volume produced by an undeveloped meadow. Development claimed more than half of the wetlands in the lower 48 states between the late 1700s and the mid-1980s.

VEHICLE TRAVEL: TRENDS AND ENVIRONMENTAL IMPACTS

Trends

Vehicle travel has increased substantially in recent decades. Between 1980 and 1997, vehicle miles traveled (VMT) in the United States increased 63 percent. This growth rate was almost three times more rapid than population growth during the same period.

Development patterns have contributed to increased vehicle use. Investment in highway capacity encourages more vehicle travel by temporarily reducing travel time and costs. Dispersed, low-density development with significant distances between housing, jobs, schools, and shopping make walking, bicycling, or use of transit difficult for most trips. Urban design that emphasizes the automobile, such as large surface parking lots, wide streets, and a lack of sidewalks, make vehicle use more comfortable and safer than walking or bicycling, even for short trips.

Impacts

The environmental consequences of vehicle travel and dependency include degradation of air quality, greenhouse gas emissions and increased threat of global climate change, and noise.

Emissions from vehicle travel pose serious threats to ecological and human health. In 1991, air pollution from highways is estimated to have caused between 20,000 and 46,000 cases of chronic respiratory illness. Atmospheric deposition of vehicle pollutants into bodies of water also adversely affects water quality. The economic costs of air pollution in terms of health impact, crop damage, and building and materials damage are significant.

Transportation is also a significant source of greenhouse gas emissions. The accumulation of greenhouse gases in the atmosphere is widely associated with changes in global climate that could raise sea level and increase the frequency and severity of extreme weather events worldwide. Although motor vehicle emissions of most air pollutants have declined since 1970 due to improved technologies and cleaner fuels, increasing VMT growth threatens to reverse this trend. Greenhouse gas emissions from motor vehicles have been increasing rapidly, fueled by increased vehicle travel.

DEVELOPMENT PRACTICES TO REDUCE ENVIRONMENTAL IMPACTS

Although the built environment inevitably affects the natural environment, communities can avail themselves of techniques for minimizing the "environmental footprint" of development. Patterns of development and its design greatly affect the level of direct environmental impacts associated with urban form. Environmentally sensitive development patterns minimize habitat and water

quality impacts. They also decrease dependence on motor vehicles, reducing air pollution and greenhouse gas emissions. Environmentally sensitive development patterns and practices are summarized below.

Compact Development

Compact development can accommodate growth while minimizing use of undeveloped land. Techniques for encouraging compact development include the following:

- *Infill development.* By accommodating new growth in an already urbanized area rather than using up new land on the periphery of a region, infill development minimizes growth in impervious surface area and thus runoff. Because infill takes place in a developed area, it is often accessible via transit or walking, and requires shorter trip distances than development on the periphery.

- *Brownfield redevelopment.* EPA defines brownfields as "abandoned, idled, or underused industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental consequences." A special type of infill, brownfields take advantage of the benefits of infill development. Developing brownfields reduces risk to communities by cleaning up contaminated sites.

- *Cluster development.* By reducing lot sizes and employing narrow and shorter road widths and lengths, cluster developments typically have less impervious surfaces than more dispersed development patterns do.

Because compact development uses up less land area, it can reduce habitat disruption and adverse impacts on wildlife, vegetation, and water quality. Regional travel studies have found that most compact development patterns produce less vehicle travel and fewer emissions of air pollutants than dispersed development patterns do. New development in a regionally central infill site can generate significantly less motor vehicle air pollution than the same development on a "greenfield" site.

Reduced Impervious Surfaces and Improved Water Detention

Land use measures can improve water quality by reducing impervious surface area and regulating the flow of stormwater. These measures include:

- Narrowing and shortening streets and minimizing the provision of parking areas

- Using porous surfaces when feasible, such as lattice blocks and bricks set in sand, rather than concrete and asphalt

- Detaining stormwater for short periods in swales and filter strips and for longer periods in ponds and wetlands

- Using special landscaping practices, such as the application of mulch to retain soil moisture and conserve water usage

Safeguarding Environmentally Sensitive Areas

The impacts of development depend not only on how much land is developed but also on the location and type of land. Sensitive natural areas such as streams, wetlands, floodplains, steep slopes, mature forests, swamps, critical habitat areas, and shorelines can be safeguarded through the following measures:

- Minimize impacts. The first approach should always be to avoid disturbing sensitive areas. If impacts are unavoidable, then development should be designed to minimize impacts and limit disturbance to points of least sensitivity.
- Create buffers and greenbelts. A "green corridor" can be preserved along the banks of rivers, streams, or other sensitive environmental habitat to protect these areas from development.

Mixed-Use Developments

In mixed-used developments, complementary functions are located close together. This kind of development has the potential to use parking and transportation infrastructure more efficiently, thus requiring less pavement and reducing runoff. By decreasing travel distances, mixed-use development can reduce average vehicle trip lengths and increase the potential for individuals to use nonautomobile travel modes. Examples of mixed-use development include the following:

- Mixing retail and office uses with residential development
- Mixing uses at employment and commercial centers
- Developing a subregional balance of jobs and housing

Transit Access

Efficient transit networks can serve urban areas effectively, reducing fuel consumption, pollutant emission, and traffic congestion. Compact regions with a limited number of subregional centers linked by transit can support transit ridership and reduce VMT compared with other regional development patterns. Locating high-density commercial and residential development around transit stations improves accessibility to transit since more households are within walking distance of the facilities.

Microscale Urban Design Features

Enhancing the environment for nonmotorized travel such as walking and bicycling can lead to reduced vehicle travel. Microscale urban design features that improve the pedestrian environment include sidewalks, clearly marked crosswalks and walk signals, lighting, and other amenities like shade trees, benches, and streetscapes designed with the pedestrian in mind. Features that improve the bicycling environment include bicycle paths and lanes on streets, bicycle parking, and signage to identify recommended bicycle routes and raise awareness of drivers to bicycle traffic.

SYNERGIES

Many of the land use measures described in *Our Built and Natural Environments* can have positive environmental effects. Their efficacy in particular locations, however, depends on how well they are implemented and how they are combined with each other and with other programs. Communities that offer their residents lasting environmental, economic, and social benefits usually adopt a synergistic method of planning—one that incorporates multiple beneficial aspects of design, according to the particular needs and characteristics of a community.

CONCLUSIONS

Urban form directly and indirectly affects the quality of our nation's air, water, and wildlife habitat. *Our Built and Natural Environments* provides a summary of the current understanding of these effects. The evidence suggests that the way we build our communities is an important concern as the United States attempts to meet its environmental goals.