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POLICY DEBATE

How EPA research, policies, and programs can advance urban sustainability

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How can a regulatory agency with historic roots in controlling pollution implement sustainability? How does an agency organized by individual media offices for air, water, toxics, and waste develop an integrated systems approach to environmental protection? Aligning and integrating programs is crucial for sustained environmental protection, especially in urban areas. The role of the U.S. Environmental Protection Agency (EPA) extends beyond setting national standards for air and water, protecting against chemical discharges, and restoring contaminated lands. The agency has the potential to become a national environmental architect by promoting research and innovation targeted at urban sustainability. To develop tools for creating a truly sustainable urban environmental infrastructure, EPA must develop approaches for adapting to potential climate change impacts on urban systems. In short, EPA needs an urban environmental strategy.

KEYWORDS: environmental protection, EPA, management tools, urban environments, climate change, public policy, sustainable development

Introduction

The Heinz Center's (2002) first report on *The State of the Nation's Ecosystem* has a chapter on urban and suburban areas, which observes that "thinking of America's cities and suburbs as an ecosystem does not come automatically to many people."[1] Yet the unconventional urban ecosystem, where Americans spend most of their time, is affected by policies and programs of the U.S. Environmental Protection Agency (EPA). In 2000, 80% of the United States population lived in urban areas within 200 miles of either an ocean coast or the Great Lakes. Between 1973 and 1992, the urbanized land in 16 metropolitan areas examined in a U.S. Geological Survey study increased by an average of 173 square miles (Auch et al. 2004).[2] Achieving sustainability in an urban ecosystem requires that dozens of stakeholders—including residents, community groups, businesses, realtors, developers, city planners and managers, and federal agencies—interact in a coordinated manner. This is clearly not easy, yet linkages among green building design, green engineering, low-impact development, and smart growth are taking root in many communities.

EPA is an important player in urban environmental sustainability, setting national standards for air and water, protecting against chemical discharges, and working to restore contaminated lands. As our discussion will show, EPA has the potential to become a national environmental architect, helping stakeholders to develop urban sustainability practices, especially practices related to the potential impact of climate change on urban water systems.

Following a general discussion of urban ecosystems, this article explores how a regulatory agency historically rooted in pollution control can interpret and implement sustainability in an urban environment. It then addresses how such an agency, organized by individual media offices (air, water, toxics, and waste), can develop an integrated systems approach to environmental protection. The article concludes with suggestions on how EPA can develop an urban sustainability strategy.

The Built Environment: An Urban Ecosystem

In the past, little or no concern was given to how urban development might seriously impair the natural infrastructure and its concomitant ecosystem ser-

[1] The Heinz Center plans to publish a fully revised version of this report in late 2007.
[2] The cities included in the study were Atlanta, Boston, Chicago, Denver, Houston, Las Vegas, Memphis, Minneapolis-St. Paul, Orlando, Phoenix, Pittsburgh, Raleigh-Durham, Reno-Sparks, Sacramento, Seattle-Tacoma and Tampa-St. Petersburg.

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vices, such as the ability to absorb pollutants and render them harmless, to cleanse air and water, and to prevent storm and flood damage. Today, we are more aware that urban development can affect energy use, indoor and outdoor air quality, ecosystem quality and services, and natural habitat protection. The construction of roads, roofs, and other impervious surfaces leads to degraded water quality by altering stream flow and watershed hydrology, reducing groundwater recharge, and increasing runoff volume, stream sedimentation, and water acidity: a one-acre parking lot produces almost 16 times as much stormwater runoff as an undeveloped meadow of the same size. The EPA's *Draft Report on the Environment* identifies impervious surfaces and the extent of urban and suburban developed land as key indicators of the health of the water and terrestrial ecosystems.[3] Many tools are now available to support low-impact development that can significantly reduce water runoff and contamination. The EPA is using its Washington, DC headquarters as a testing ground for these new approaches (USEPA, 2006a).

We have also come to realize that building design is crucial in the urban ecosystem, for buildings account for 68% of electricity consumption, 40% of total energy use, and 38% of greenhouse-gas emissions (EIA, 2003). Recent studies project that by 2030 there will be 106.8 billion square feet of new development, about 46% more built space than existed in 2000—a remarkable amount of construction to occur within a generation; moreover, in 2030 about half of the buildings in which Americans live, work, and shop will have been built since 2000. By 2030 about 97.3 billion square feet of existing buildings will be replaced; new and rebuilt development will amount to 204.1 billion square feet, equal to almost 90% of the built space that existed in 2000. All of this adds up to about US$30 trillion in total new development (including infrastructure) that will occur between 2000 and 2030 (Nelson, 2004; 2006).

Anticipating these urban challenges, business leaders, developers and architects, nongovernmental organizations, cities, and federal agencies are combining forces to help shape a new generation of urban development and building design and retrofitting. In efforts to reduce energy consumption and greenhouse-gas emissions, former President Bill Clinton is helping to create a US$5 billion green building fund to retrofit existing buildings in a program that is bringing together cities, banks, and four energy-service providers. In new construction, the U.S. Green Building Council (USGBC), the foremost coalition joining leaders from all building-industry sectors, is working to promote buildings that are profitable, environmentally responsible, and healthy places to live and work (see USGBC, 2007). The USGBC's hallmark program, the Leadership in Energy and Environmental Design (LEED®) Green Building Rating System, is the nationally accepted benchmark for the design, construction, and operation of high-performance buildings.

In an urban ecosystem, achieving sustainability requires an integrated approach to environmental management and the establishment of linkages among community, ecology, and economy. The link between economic development and environmental protection is especially important. Metropolitan areas are now the major drivers of the country's economy. From 2000 to 2006, 90.5% of United States economic growth took place in metropolitan areas, while in 2006 payrolls included 116 million workers and GDP totaled US$11.4 trillion, an overwhelming 86.7% of the nation's total (Global Insight, 2007).

Increased urban development has focused attention at all levels of government on quality of life, urban sprawl, and growing demand for transportation and energy. Population growth has historically led to greater and more concentrated use of energy, water, and materials, and concomitant growth in waste, increasing air, water, and land pollution, with associated harm to ecosystems and human health. Economic growth has generally required increasing quantities of energy, materials, and water from expanded agriculture and industry, leading to more waste, toxic substances, and air and water pollution. Land and ecosystems change as materials are extracted, goods produced, infrastructure built, and wastes disposed.

The effect of air quality on respiratory diseases demonstrates the links between human health and environmental quality in the urban environment. As Howard Frumkin and his colleagues have shown, a healthy urban environment can also benefit a broad range of physical and mental health issues. They write, "Smart Growth is like a medicine that treats a multitude of diseases—protecting respiratory health, improving cardiovascular health, preventing cancer, avoiding traumatic injuries and fatalities, controlling depression and anxiety and improving well-being" (Frumkin et al. 2004).

These data and examples illustrate the important economic and health impacts of urban environments and underscore that EPA—working with cities and states, developers, realtors, investors, and retailers—can significantly enhance economic growth while promoting more sustainable environmental approaches. The growing national focus on green design and low-impact development, on reducing

[3] *EPA's 2007 Report on the Environment: Highlights of National Trends.* Peer Review and Public Comment Draft is available at http://www.epa.gov/indicators/docs/roe-hd-draft-08-2007.pdf.

stormwater runoff and greenhouse-gas emissions, and on improving air quality and human health is creating a new government-business framework seeking to more effectively balance economic growth and environmental protection. The threat of severe climate-change effects, including altered frequency and intensity of precipitation and increased energy demands, makes sustainable urban planning a financial and social necessity.

EPA Programs and Sustainable Urban Development

When President Nixon created EPA in 1970, he recognized the interconnectedness of the environment and the inherent cross-media nature of environmental protection. His plan to establish EPA noted that, for pollution-control purposes, "the environment must be perceived as a single, interrelated system" (EPA, 2007d). Since then, EPA has struggled to deal with the environment as an integrated system. At the agency's 15th anniversary, former Administrator Russell Train expressed his concern with EPA's "compartmentalized nature" and its resulting ineffectiveness in dealing with pollutants, which "tend to move readily among air, water, and land" (EPA Journal, 2007b). In the same year, Administrator Lee Thomas stressed the need for cross-media reviews so that "we don't just transfer pollutants from one medium to another" (EPA Journal, 2007a). The urban ecosystem clearly requires integration across media, and EPA is pursuing this objective. Although the built environment is a major area affecting human health and ecosystem protection, no single federal statute governs it. Indeed, states and local jurisdictions have major responsibilities regarding the built environment.

Integrating and aligning programs is a key to achieving sustained environmental protection. A recent report by a panel of the National Academy of Public Administration (NAPA) identifies current challenges facing EPA, headed by the complex environmental problems involving both point and nonpoint sources of pollution. The report authors found especially relevant to the urban environment the realization of "a major gap in the ability of current EPA programs to mobilize the multiple programs, federal agencies, state and local government, and other parties that must play important roles in achieving national goals to improve ambient environmental conditions" (Howes et al. 2007).

The NAPA report emphasizes integrating across problems, promoting collaborative problem solving and leadership. To highlight the challenge to EPA, the NAPA authors examined the Chesapeake Bay Program and found that reaching its pollution-prevention goals would require joint efforts among numerous government and private entities, including:

- Six states, the District of Columbia, and 3,169 local governments
- 23 federal agencies
- 678 watershed associations
- A large number of "riverkeepers"
- 2 interstate river basin commissions
- 30 regional councils (multi-county councils of local governments)
- 32 state-created tributary strategy teams
- 87,000 farm owners
- 5–6 million homeowners
- Hundreds of lawn-care companies
- An uncounted number of land developers, home-builders, and construction companies
- Agribusinesses and other companies that pollute the Bay
- A huge number of civic and nonprofit organizations (Howes et al. 2007).

The challenge of facilitating the interaction among key stakeholders is recognized in many of EPA's urban ecosystem programs. A sampling of agency initiatives that at least in part concern urban sustainability is highlighted in Table 1 and discussed in the following paragraphs.

Green Building

The greening of building construction is being promoted both within the federal government and in private industry. In January 2006, more than 150 federal facility managers and decision makers met for the first White House summit on federal sustainable buildings. The federal agencies signed an agreement to promote high performance and sustainability in building design (Interagency Sustainability Working Group, 2007). Executive Order (EO) 13423, issued in January 2007, establishes new and updated goals, practices, and reporting requirements for environmental, energy, and transportation performance and accountability (Bush, 2007). In the area of sustainable design and high-performance buildings, the new EO mandates five guiding principles for all new construction and major renovations: integrating design, optimizing energy performance, protecting and conserving water, enhancing indoor environmental quality, and reducing materials' environmental impacts. The EO also has set an aggressive goal for applying these practices to existing federal capital assets over the next decade. To address the need for a comprehensive guide for procuring green building products and construction services within government, EPA has partnered with the Federal Environmental Ex-

Table 1 EPA programs concerning the built environment.

EPA Program (Office)	Program Objective
Buildings: Facilities Management and Green Design (OA, OPPTS, OPEI, ORD)	Help identify green building criteria and standards.
Land: Smart Growth (OPEI)	Help design low-impact and green communities through sharing best practices and promoting ten development principles.
Land: SMARTe (ORD)	Provide web-based decision-support tool to help developers evaluate future reuse options for a site or area.
Land: Brownfield Revitalization (OSWER)	Revitalize contaminated sites to be economically productive.
Land: Environmentally Responsible Redevelopment and Reuse (ER3) (OECA)	Use enforcement and incentives to promote sustainable development of contaminated sites.
Water: Sustainable Water Infrastructure (OW)	Better manage utilities, including full-cost pricing, efficient water use, and watershed approaches.
Water: WaterSense (OW)	Help conserve water for future generations by providing information on products and programs that save water without sacrificing performance.
Water: National Pollution Discharge Elimination System (NPDES) (OW)	Control water pollution by green infrastructure and regulate point sources that discharge pollutants into United States waters.
Energy Use: ENERGY STAR (OAR)	Evaluate and test energy efficiency of products in more than 50 categories and provide information on green building design and energy efficiency.
Air: Air Toxics Strategy and Modeling (OAR) (ORD)	Identify and monitor urban air toxics from stationary, mobile, and indoor sources.
Air: Community-Based Air Quality Programs (OAR)	Support air-toxics projects in about 30 communities across the nation, helping inform and empower citizens to make local decisions concerning the health of their communities.
Indoor Air: Indoor Environment Management Research (ORD**)**	Improve understanding of relationships among emission sources; heating, ventilating, and air-conditioning (HVAC) systems; air-cleaning devices; and indoor air quality.
Climate: Climate Impact Assessment Research (ORD)	Integrate remote and ground-based data and dozens of models to assess potential impacts of climate change.

The acronyms in this table represent EPA offices: OA, Office of the Administrator; OPEI, Office of Policy, Economics, and Innovation; OSWER, Office of Solid Waste and Emergency Response; OW, Office of Water; OAR, Office of Air and Radiation; OECA, Office of Enforcement and Compliance Assistance; OPPT, Office of Prevention, Pesticides, and Toxics, and ORD, Office of Research and Development.

ecutive and the Whole Building Design Guide (WBDG) to develop the Federal Green Construction Guide for Specifiers (see Whole Building Design Guide, 2007). This voluntary guidance document recognizes approaches beyond minimum compliance with regulations and assists federal agencies in meeting pollution prevention and other green mandates already in place. The EPA received authority under the earlier EO 13101 to guide agencies in meeting these requirements (Clinton, 1998).

Smart Growth

At its core, smart growth involves development decisions on the broad universe of issues affecting everyday lives—people's homes, health, schools, taxes, daily commute, surrounding natural environment, community economic growth, and opportunities regarding their dreams and goals. Through grants, technical assistance, incentives, and recognition programs, EPA assists local communities in futures planning. Development strategies that protect critical habitat, reduce automobile emissions, clean up and revitalize brownfields, and reduce runoff of polluted water link smart growth and the environment. Today, smart growth programs are increasingly focused on reducing carbon footprint and energy use. The EPA's Smart Growth Awards recognize innovative cities and communities across the country.

SMARTe

Sustainable Management Approaches and Revitalization Tools (SMARTe) is one of many EPA open-source web-based decision-support systems for developing and evaluating scenarios for reusing contaminated land. SMARTe contains guidance and analytical tools for all aspects of the revitalization process, including environmental, economic, and social concerns. The SMARTe website provides information on newly available tools, technologies, and

land-revitalization approaches (see SMARTe.org, 2007).

Brownfield Revitalization

EPA's Smart Growth Program works closely with the agency's brownfields program. The United States has more than 450,000 brownfields—properties characterized by the actual or potential presence of hazardous substances, pollutants, or contaminants that may complicate expansion, redevelopment, or reuse. Since its inception in 1995, EPA's brownfields program has empowered states, communities, and other economic redevelopment stakeholders to work together to prevent, assess, safely clean up, and sustainably reuse brownfields. Across the country, cleaning up and reinvesting in contaminated properties increases local tax bases, facilitates job growth, uses existing infrastructure, reduces pressures to develop open land, and improves and protects the environment.

Environmentally Responsible Redevelopment and Reuse (ER3)

EPA is using its enforcement and incentive programs to promote sustainable cleanup and redevelopment of contaminated sites. The ER3 program identifies and provides enforcement and incentives to developers and property owners to encourage sustainable development. It also develops partnerships with federal, state, public, and private entities to establish a network of expertise on sustainable development issues and promotes sustainable redevelopment of contaminated properties through education and outreach.

Sustainable Water Infrastructure

With water becoming scarce, the aging water infrastructure throughout the United States is a cause for much concern. The EPA's extensive gap analysis of water infrastructure lays out critical needs in drinking-water treatment, distribution, and storage and in wastewater collection, treatment, and reuse. In 2002, EPA estimated in its *Clean Water and Drinking Water Gap Analysis Report* that if investment in water and wastewater infrastructure does not increase to address anticipated needs, the funding gap over 2000–2019 could grow to US$122 billion for clean water capital costs and US$102 billion for drinking water capital costs (USEPA, 2002). The municipal water sector accounts for 40% of national water usage. Much of the country's water infrastructure was built in the 30 years following World War II and needs major repairs and upgrades. Urban sustainability clearly depends on reliable and well-maintained water and wastewater treatment, storage, and conveyance systems. The EPA's Sustainable Infrastructure Initiative for Water and Wastewater is guiding efforts to change how the nation views, values, manages, and invests in its water infrastructure. The EPA is working with the water industry to identify best practices that have helped many water utilities address a variety of management challenges and to extend these practices to a greater number of utilities.

WaterSense

This EPA tool promotes sustainable water use by identifying effective and efficient products that deliver needed services. Public education and product labeling can change behavior. Developing any environmental label requires working with industry stakeholders to ensure full openness, reliability, and mutual support. WaterSense evolved from a series of stakeholder meetings across the country to get input on designing a national, voluntary, market-based program for promoting water-efficient products. Research has shown that such technologies and practices help homeowners save natural resources and reduce water consumption and costs. The average family of four uses 400 gallons of water every day. The arid West has among the highest per capita residential water usage because of landscape irrigation. The EPA's WaterSense label identifies water-efficient products that are found to be 20% more efficient in their water use than other products.

National Pollution Discharge Elimination System

Water pollution degrades surface waters, making them unsafe for drinking, fishing, swimming, and other activities. As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into United States waters. Since its introduction in 1972, this program has significantly improved the nation's water quality. Moving toward sustainability, the NPDES program promotes green infrastructure as a cost-effective and environmentally friendly approach to reduce stormwater and other excess flows entering sewer systems. Green infrastructure is a way to protect surface waters and drinking-water supplies, reduce drinking-water and stormwater treatment costs, mitigate urban heat-island impacts, and provide more sustainable water-resource management. Green infrastructure approaches, such as low-impact development, use on-site, natural systems, including forested areas, rain gardens, and green roofs, to cleanse water and reduce excess volume by filtering and treatment with plants, soils, and microbes. Green infrastructure can reduce our reliance on pipes, channels, and engineered treatment systems that are costly to build, operate, and maintain. In April 2007, EPA and four national

groups signed an agreement to promote green infrastructure to reduce stormwater runoff and sewer overflows (USEPA et al. 2007).

ENERGY STAR

Launched in 1992, this voluntary labeling program identifies and promotes energy-efficient products that reduce greenhouse-gas emissions. Beginning with computers and monitors, EPA later expanded product labeling to other office equipment and to residential heating and cooling equipment. In 1996, the agency joined with the U.S. Department of Energy in certifying products in additional categories. The ENERGY STAR label is now widely recognized as identifying major appliances, office equipment, lighting, home electronics, and other products that match or exceed the performance of competing models while using less energy and saving money. The EPA has further extended the ENERGY STAR label to cover new homes and commercial and industrial buildings (see ENERGY STAR, 2007). Through its partnerships with more than 8,000 private- and public-sector organizations, ENERGY STAR delivers the technical information and tools that purchasers need to choose energy-efficient solutions and best management practices. The program has delivered energy and cost savings across the country, saving businesses, organizations, and consumers about US$12 billion in 2005 alone. Over the past decade, ENERGY STAR has driven the expansion of such innovations as LED traffic lights, fluorescent lighting, standby-energy use, and power-management systems for office equipment.

Urban Air Toxics Strategy

Under the Clean Air Act, Congress instructed EPA to develop a strategy for air toxics in urban areas with broad risk-reduction goals encompassing all stationary sources of air pollution and with specific actions to address the many smaller local sources of air pollution. The Urban Air Toxics Strategy is the agency's integrated framework for addressing air toxics in those areas by examining stationary, mobile, and indoor source emissions (see USEPA, 2007b). Air toxics can pose special threats in urban areas because of the large number of people and the multiple sources of toxic air pollutants, such as cars, trucks, large factories, gasoline stations, and dry cleaning plants. Some of these sources may not individually emit large amounts of toxic pollutants, but in combination they pose significant health threats, particularly for the elderly, children, and other sensitive populations. The Urban Air Toxics Strategy focuses on the impact of toxic emissions on minority and low-income communities that are often close to industrial and commercial urbanized areas. The EPA air-transport models are critical decision tools in helping to evaluate air-dispersion patterns. These models form the core of a set of decision-support tools to help assess air quality as it relates to urban development patterns.

Community-Based Air Quality Programs (CBAQP)

Many of the more than 30 CBAQP projects underway are focused on integrated urban planning that links issues of development, transportation, and air quality. One of the largest projects is Sustainable Environment for Quality of Life (SEQL), an integrated environmental initiative encompassing 15 counties in the Charlotte/Gastonia/Rock Hill region of North and South Carolina (SEQL, 2007). SEQL involves business and industry groups, economic development, and environmental stakeholder groups working with elected officials and local government staff toward sustainable solutions to regional growth. Projecting and assessing this region's future growth patterns in an integrated manner is a key element of the SEQL program. A set of decision-support tools called ReVA (Regional Vulnerability Assessment) has been developed to help decision makers quantitatively assess ecosystem and environmental impacts of different development options.[4] Other community-based air-quality projects underway in New Haven, Cleveland, and St. Louis also are also integrating urban planning, transport, and air quality into sustainable urban policies (USEPA, 2007c).

Indoor Environment Management Research

Indoor air quality is not a new topic for EPA but it has a renewed sense of importance in light of urban population increases, aging, and the potential for billions of dollars of new construction. The issue regarding indoor environment now is not only urban air quality, but energy efficiency and worker productivity as well. The EPA's National Risk Management Research Laboratory is conducting fundamental and applied research on programs to enhance energy efficiency and control indoor air pollution. The research program has focused on developing standard methods and models for specific classes of potential indoor pollution sources (such as paints, cleaners, and adhesives), for large-chamber emission testing, and for technology verification (such as for air cleaners and office furniture). ASTM International, the global standards-developing organization, has adopted several testing and measurement procedures formulated by this EPA program.

[4] EPA researchers, who have long focused on urban planning, in 2000 compiled a summary of available models to help decision makers (USEPA, 2000).

Global Change Research

Because urban infrastructure requires long-term investment, wise decision making must consider the potential impacts of climate change on water resources. The EPA's broad-based climate-assessment program is included here to emphasize the importance of developing and using assessment models in making sustainable decisions. With billions invested in water infrastructure in the United States, potential changes in the intensity and frequency of rainfall, snow, and other storm events can significantly affect the quantity and quality of water available and the infrastructure required to collect and treat urban wastewater and stormwater. Implications for combined sewer- overflow systems are discussed later in this article.

A Model for Connecting the Dots: Green Building Workgroup (GBWG)

Although the programs listed in Table 1 were independently developed, each seeks to advance sustainability in urban development and building design. The EPA has supported these efforts by committing to green its own facilities, establishing the Sustainable Facilities Practices Branch, and adhering in its construction projects to the green building standards. Recognizing the need to coordinate across these numerous programs, EPA staff created the Green Building Working Group (GBWG) to guide programs, partnerships, communications, and operations that influence building and development. The GBWG is a model of how to connect the dots and thus focus and leverage ongoing programs to advance green building goals (USEPA, 2005).[5]

In developing its overall strategy, the GBWG recognizes that for EPA to meet its mission responsibilities and promote economic development and sustainable practices, it has to foster the widest possible adoption of environmentally preferable building and development techniques. There is no shortage of green designs and technologies, but the challenge is to move from a small percentage of the market to the mainstream. The GBWG also recognizes that, because EPA's building and development programs are largely voluntary, any GBWG strategy must partner with a variety of building sectors, governments, and green building organizations to promote sustainability in the marketplace by providing information, recognition, and other incentives (USEPA, 2006c).[6]

Thinking strategically about sustainability and the built environment, EPA's GBWG adopted a strategy with two goals: facilitating leadership and fostering innovation. In adopting this approach, EPA is primarily looking to the marketplace rather than regulation to advance sustainability. The approach to transformation is important at this stage in that green building and other sustainability programs, although growing dramatically, remain a small segment of the market and their success could yet be derailed by economic, social, political, and/or other factors.

Recent estimates of potential growth are impressive. In 2006, the National Association of Homebuilders reported that inquiries into green practices had increased by more than 250% from the previous year. Commercial green building and development projects will increase 30% over the next five years, according to estimates by the National Association of Industrial and Office Properties. The organization also explains that most large corporations that issued sustainability reports in 2005 stated that they want to build and occupy real estate that reflects their values, including green building practices. A recent survey by McGraw-Hill Construction projected the near-term market growth in green construction for several building sectors: education, 65%; government, 62%; institutional, 54%; office, 58%; health care, 46%; residential, 32%; hospitality, 22%; and retail, 20%. Owners and developers of commercial and institutional properties in North America are advancing green development through state-of-the-art tools, design techniques, advanced green products, and creative use of financial and regulatory incentives (Ortega-Wells, 2006).

The GBWG illustrates EPA efforts to overcome traditional barriers and integrate the agency's diverse programs. Rather than creating a separate sustainability program, the GBWG aims to integrate the principles of sustainability into existing programs. It is thus an effective and instructive model for making sustainability operational.

Toward an EPA Urban Sustainability Strategy

Achieving sustainability in the built environment is not something EPA or any other agency can achieve by regulations alone. What we know today about the impacts of urban development and building design on environmental quality and human health has to be translated into practical policies involving dozens of stakeholders. Building on a common interest among diverse stakeholders, EPA can be a leader

[5] The EPA-sponsored Construction Industry Compliance Center provides guidance for EPA building and development regulatory programs (see CICA, 2007).

[6] In 2006, EPA signed a Memorandum of Understanding with the American Institute of Architects (AIA) Committee on the Environment to advance sustainable development by partnering on key smart growth and green building activities (see USEPA, 2006b).

in promoting partnerships and fostering innovation toward urban sustainability.

The clearest immediate need is to have a broad "urban sustainability strategy" with unambiguous goals and metrics. Given the extent of urban development and building redevelopment, EPA has an opportunity to significantly influence future development and be-come a nationally recognized "environmental architect." We use this phrase to emphasize the importance of designing and planning in an integrated manner and to convey a different sense of EPA. The challenge is to think of such development in an integrated manner, rather than simply as a collection of related programs like those shown in Table 1.

Defining urban sustainability goals and metrics is important. The value of the 2002 Heinz Center report is its focus on indicators of change and assessing the quality of available data. This report identified 15 indicators that provide critical links to environmental parameters, but explained that many of the indicators have incomplete and inadequate long-term data records. Developing urban sustainability indicators across EPA programs can serve many purposes:

- Assist urban decision makers in understanding the practical meaning of achieving sustainability.
- Provide guidance for decision makers in designing and implementing policies to advance sustainability.
- Enable decision makers to see the interconnections among issues so they can make decisions based on comprehensive understanding.
- Promote cross-media policies and strategies within EPA.
- Serve as a framework for constructive dialogue and collaboration among business, government, and nongovernmental institutions.
- Provide on-going access to the data and information that support decision making for sustainability.

The GBWG, re-enforced by recommendations of NAPA and other outside panels, demonstrates the importance of EPA in encouraging sustainable decisions by facilitating dialogue among diverse stakeholders and promoting collaborative problem solving. As a national environmental architect, EPA is in a unique position to make several major contributions:

- Bring together different industry sectors and subsectors to collaborate on setting goals, measuring results, coordinating, and overcoming barriers to green development.
- Facilitate the coordination of federal, state, tribal, and local government policies; refine codes, specifications, and standards; and otherwise aid implementation of sustainable practices.
- Work with voluntary-based standards organizations to continue the development and advancement of voluntary consensus standards related to green design.

Sustainability Research: Helping Decision Makers Make Better Decisions

EPA can also be effective in promoting innovation and research that demonstrates synergies in the urban ecosystem. Building on a solid base of air-pollution modeling and urban system design, as well as engineering and technology development, EPA can greatly improve the quality of decision making, today and in the future.

The term "sustainability research" has become popular in academic circles. From EPA's perspective, sustainability science is developing the underlying knowledge that allows sustainable decision making. For natural resource managers, this means understanding how to provide maximum services today and in the future. For urban planners, this means understanding how to build cost-effective and efficient systems that protect both human health and the environment. For industrial decision makers, this means understanding how to enhance economic growth while minimizing the environmental footprint of production activities.

Sustainability science aims to anticipate problems and promote innovation. In one pilot project, EPA is working with community planners to develop a master plan for the sustainable revitalization of Stella, Missouri, which was chosen as a pilot for the Ozark Mountains area. At a May 2007 town-hall meeting, local citizens enthusiastically approved the final plan, which captures demographic and land-use changes and presents criteria for sustainable development. A local newspaper editorial proudly noted, "Stella, Missouri, was given the opportunity to be a model for all the small communities in the USA." With the plan moving toward implementation, EPA is helping to establish a baseline of environmental variables to evaluate planning results over the next decade. The Stella example demonstrates how EPA—using its full science capabilities and planning tools such as SMARTe—is helping local communities address important sustainability issues. Using EPA models like Integrated Climate Land Use Scenarios (ICLUS), EPA is working with communities to assess current trends and evaluate impacts of future-growth scenarios.

Climate change may seriously affect future land-use practices, particularly in urban environments. For this reason, Table 1 includes the Global Change Research Program as an EPA program affecting urban sustainability. Under this program, the ICLUS project is developing scenarios for land use, housing density, and impervious surface cover for the coterminous United States for each decade through 2100. These scenarios will be based on the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES) social, economic, and demographic storylines. These scenarios assess the effects of changes in climate and land use across the United States and identify areas where climate/land-use interactions may exacerbate impacts or create adaptation opportunities. Demonstrating efforts to integrate across programs, these scenarios will use the USGBC's research to help determine the national-scale benefits of different levels of smart growth. The Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) model that EPA will release in late 2007 will include ICLUS scenarios, allowing users to consider the impact of changes in both land use and climate on water quality (USEPA, 2007a).

Looking ahead, EPA can be effective in helping a variety of decision makers (such as investors, realtors, and local governments) meet regulatory requirements and promote economic development. One area of significant investment is in water and wastewater treatment facilities. One major potential consequence of climate change relates to the impacts of storm events on wastewater-collection systems or combined sewer systems (CSSs), which are designed to collect municipal wastewater and stormwater runoff in a common transmission system (sewer). Under dry conditions, the CSSs transport municipal wastewater and during storm events they also transport stormwater. These systems are prevalent in older cities, particularly in the Midwest, the Great Lakes, and the Eastern United States. CSSs can overflow if they lack adequate capacity to transport the combined volume of municipal wastewater and stormwater during extreme or frequent storm events, resulting in combined sewer overflow (CSO) events. Municipalities that are served by sanitary sewer systems can also be affected by storm events due to infiltration and inflow of stormwater, depending on the age and integrity of the sanitary sewer system. The additional flow in the sewer systems can exceed the capacity of the collection system, resulting in release of untreated wastewater through sanitary sewer overflow (SSO) events. CSOs and SSOs can lead to uncontrolled releases of high concentrations of pathogens, inorganic and organic contaminants, sediments, and solids into the environment. As a component of the NPDES permitting process (see Table 1), communities must define mitigation measures to reduce CSO incidents.

What makes all of this so interesting is that current standards allow for four CSO incidents per year, a number that IPCC scenarios suggest will be exceeded given the likely future increase in intense rainfall events. At issue today is how to strategically invest billions of new dollars into developing more robust and sustainable urban water and wastewater systems. The answer is clearly related to developing an integrated urban sustainability approach that includes climate-change scenarios. The EPA is currently assessing how such climate change can impact future urban water and wastewater systems (USEPA, 2006a). Future planning should clearly link smart growth and low impact development with CSS designs.

Conclusion

It is not often that one can predict the future. But given the worldwide trend toward urban development and the projected extent of commercial redevelopment, any course of action other than sustainable urban development and green building design will have serious environmental consequences. The marketplace may drive a good deal of this kind of development. Sustainable urban systems are going to be increasingly linked to commercial and residential development, and the public is going to increasingly ask how such development supports a company's sustainability or social responsibility goals. The public will someday confront developers and retailers, who now advocate green policies in their supply chains and products, if their large urban footprint is increasingly damaging the urban ecosystem. By contrast, a new era of public and commercial investment can set high standards for building design and low-impact development. Urban shopping centers, residential complexes, and government buildings of the future can enhance water quality, protect downstream ecosystems, promote clean air, recycle products, educate the public, and sell products.

While history has shown that EPA's air, water, and land programs have each made significant contributions in their own areas, the environmental benefits from these initiatives can be multiplied by greater coordination and by a clear focus on sustainable outcomes. History also shows that, driven by current problems, EPA has moved incrementally in policies and research to integrate sustainability more broadly. The EPA is functioning as a "virtual agency for sustainability." We see this in the common objectives of many programs related to the urban environment. What is missing is an integrated approach. We postulate that EPA can more effectively achieve its core

mission of protecting human health and the environment through a stronger commitment to policies, practices, and research that support sustainable development. In the case of the built environment, defining a set of common sustainability objectives and measures can create a strategic research and policy roadmap and maximize resources across programs. With a strong research focus and a clear policy roadmap, the agency can accomplish much more to advance environmental sustainability.

Authors' Note

The views expressed in this article are those of the authors and do not necessarily reflect official EPA policies.

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References

Auch, R., Taylor, J., & Acevedo, W. 2004. *Urban Growth in American Cities: Glimpses of U.S. Urbanization*. USGS Circular 1252. Washington, DC: United States Geological Survey, EROS Data Center. http://pubs.usgs.gov/circ/2004/circ1252.

Bush, G. 2007. Executive Order 13423. Strengthening Federal Environmental, Energy, and Transportation Management. *Federal Register* 72(17):3917–3923.

Clinton, W. 1998. Executive Order 13101. Greening the Government through Waste Prevention, Recycling, and Federal Acquisition. *Federal Register* 63(179):49641–49651.

Construction Industry Compliance Center (CICA). 2007. Construction Industry Compliance Center. http://www.cicacenter.org. August 9, 2007.

Energy Information Administration (EIA). 2003. *Annual Energy Review 2002*. DOE/EIA-0384. Washington, DC: United States Department of Energy.

ENERGY STAR. 2007. Buildings & Plants. http://www.energystar.gov/index.cfm?c=business.bus_index. November 7, 2007.

EPA Journal. 2007a. Past, Present, and Future (An Interview with Lee M. Thomas). http://www.epa.gov/history/topics/epa/15d.htm. August 13, 2007.

EPA Journal. 2007b. Views from the Former Administrators (An Interview with Russell Train). http://www.epa.gov/history/topics/epa/15e.htm. August 13, 2007.

Frumkin, H., Frank, L., & Jackson, R. 2004. *Urban Sprawl and Public Health*. Washington, DC: Island Press.

Global Insight, Inc. 2007. *U.S. Metro Economies. Employment and the Workforce. Employment and the Workforce Special Report (June)*. Prepared for the United States Conference of Mayors and The Council for the New American City. Waltham, MA: Global Insight, Inc. http://www.usmayors.org/metroeconomies/0607/report.pdf.

Heinz Center. 2002. *The State of the Nation's Ecosystems: Measuring the Lands, Waters, and Living Resources of the United States*. New York: Cambridge University Press. http://www.heinzctr.org/ecosystems/report.html.

Howes, J., Johnson, R., Mora, D., O'Neill, R., Payton, S., Posner, P., & Salamon, L. 2007. *Taking Environmental Protection to the Next Level: An Assessment of the U.S. Environmental Services Delivery System.* Washington, DC: National Academy of Public Administration. http://www.napawash.org/pc_management_studies/EPA_FULL_Report_April2007.pdf.

Interagency Sustainability Working Group. 2007. Federal Leadership in High Performance and Sustainable Buildings: Memorandum of Understanding. http://www.energystar.gov/ia/business/Guiding_Principles.pdf. November 7, 2007.

Nelson, A. 2004. *Toward a New Metropolis: The Opportunity to Rebuild America*. Discussion Paper prepared for the Brookings Institution Metropolitan Policy Program. Washington, DC: Brookings Institution. http://www.brookings.edu/~/media/Files/rc/reports/2004/12metropolitanpolicy_nelson/20041213_RebuildAmerica.pdf.

Nelson, A. 2006. America Circa 2030: The Boom to Come. *Architect Online* October 15. http://www.architectmagazine.com/industry-news.asp?sectionID=1006&articleID=385542.November 7, 2007.

Ortega-Wells, A. 2006. Under construction: the green property insurance market. *Insurance Journal West Magazine* November 6.

Sustainable Environment for Quality of Life (SEQL). 2007. Sustainable Environment for Quality of Life. http://www.seql.org/index.cfm. November 2, 2007.

SMARTe.org. 2007. Sustainable Management Approaches and Revitalization Tools–electronic. http://www.smarte.org. November 8, 2007.

United States Environmental Protection Agency (USEPA). 2000. *Projecting Land-Use Change: A Summary of Models for Assessing the Effects of Community Growth and Change on Land-Use Patterns.* EPA/600/R-00/098. Cincinnati, OH: USEPA.

United States Environmental Protection Agency (USEPA). 2002. *The Clean Water and Drinking Water Infrastructure Gap Analysis.* EPA 816-R-02-020. Washington, DC: USEPA. http://www.epa.gov/waterinfrastructure/pdfs/report_si_infrastructuregap.pdf.

United States Environmental Protection Agency (USEPA). 2005. Working Together. *Energizing EPA: Office of Administration and Resources Management's Newsletter on Energy Conservation and Sustainable Facilities.* June 2005:3. http://www.epa.gov/oaintrnt/documents/june05_508.pdf.

United States Environmental Protection Agency (USEPA). 2006a. *A Screening Assessment of the Potential Impacts of Climate Change on Combined Sewer Overflow (CSO) Mitigation in the Great Lakes and New England Regions. External Review Draft*. EPA/600/R-07/033A. Washington, DC: USEPA. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=166365

United States Environmental Protection Agency (USEPA). 2006b. Memorandum of Understanding between the United States Environmental Protection Agency and the American Institute of Architects. http://www.epa.gov/greenbuilding/pubs/aiamou.htm. August 9, 2007.

United States Environmental Protection Agency (USEPA). 2006c. *2006–2011 EPA Strategic Plan: Charting Our Course.* EPA-190-R-06-001.Washington, DC: USEPA. http://www.epa.gov/ocfo/plan/2006/entire_report.pdf.

United States Environmental Protection Agency (USEPA). 2007a. Better Assessment Science Integrating Point and Nonpoint Sources (BASINS). http://www.epa.gov/waterscience/basins. November 8, 2007.

United States Environmental Protection Agency (USEPA). 2007b. Urban Strategy. http://www.epa.gov/ttn/atw/urban/urbanpg.html. November 8, 2007.

United States Environmental Protection Agency (USEPA). 2007c. Community-Based Air Toxics Projects. http://www.epa.gov/air/toxicair/community.html. November 8, 2007.

United States Environmental Protection Agency (USEPA). 2007d. Reorganization Plan No. 3 of 1970. http://www.epa.gov/history/org/origins/reorg.htm. August 9, 2007.

United States Environmental Protection Agency (USEPA), National Association of Clean Water Agencies, Natural Resources Defense Council, Low Impact Development Center, & Association of State and Interstate Water Pollution Control Administrators. 2007. Green Infrastructure Statement of Intent. http://www.epa.gov/npdes/pubs/gi_intentstatement.pdf. August 9, 2007.

United States Green Building Council (USGBC). 2007. United States Green Building Council. http://www.usgbc.org. November 8, 2007.

Whole Building Design Guide. 2007. Federal Green Construction Guide for Specifiers. http://www.wbdg.org/design/greenspec.php. November 8, 2007.

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