

Infrastructure *2010*

INVESTMENT IMPERATIVE



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Recommended Bibliographical Listing:

The Urban Land Institute and Ernst & Young. *Infrastructure 2010: Investment Imperative*. Washington, D.C.: The Urban Land Institute, 2010.

ULI Catalog Number: I21

ISBN: 978-0-87420-145-1

Cover: The Chicago River reflects Chicago buildings. Under Mayor Richard M. Daley, Jr., the city launched a major effort to clean up the once-polluted Chicago River.



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Infrastructure 2010: Investment Imperative

Infrastructure 2010: Investment Imperative has a simple thesis: We must start treating infrastructure like an investment. Too often we treat it as anything but, funneling spending through siloed formulas and sidestepping critical questions about the country's longer-term infrastructure strategy and vision. The nation's vast infrastructure needs offer an opportunity to create much-needed jobs while making the lasting, integrated infrastructure investments that will lay the foundation for future prosperity.

The 2010 infrastructure report—the fourth in an annual series produced by the Urban Land Institute and Ernst & Young—examines global infrastructure trends and, for the first time, addresses water issues in depth. Water is the hidden infrastructure conundrum, with aging pipes and inadequate systems running headlong into rapid population growth in America's most water-constrained regions. *Infrastructure 2010* probes water challenges in the United States and abroad, including the overlapping challenges of aging pipes, failure to conserve, contamination threats, and the difficult issue of effective water management. Building on extensive research, interviews, and data collection, *Infrastructure 2010* reviews the specific water issues and concerns confronting 14 metropolitan areas throughout the country.

Across the nation, there are signs of a renewed commitment to infrastructure. Innovative state and local govern-

ments are taking the initiative on building and funding new and often costly infrastructure projects, including transit and rail. And more and more Congressional and administration leaders recognize the importance of infrastructure to national competitiveness, even if they can't agree on priorities or how to fund it. At the federal level, creative partnerships between agencies—including the sustainability partnership between USDOT, HUD, and the EPA—are linking and coordinating environmental, transportation, and land use programs. Federal agencies are experimenting with new grant programs that award dollars in more merit-based, competitive ways, and revising old grant criteria to be more holistic and wide ranging. These are promising moves, but more needs to be done.

As in previous editions, *Infrastructure 2010* provides a glimpse of global infrastructure initiatives in 16 major international markets, highlighting China's continued strong investments in rail and water infrastructure. This year's report also reviews water conservation efforts in Australia.

An investment in infrastructure is a promise to future generations. Done well and strategically, it can help guarantee increasing prosperity and rising standards of living. Countries around the world—in particular, China, but also those in Europe and elsewhere in Asia—recognize the infrastructure investment imperative. America must now do the same.



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Falling behind global competitors, the United States struggles to gain traction in planning and building the critical infrastructure investments that are necessary to ensure future economic growth and support a rapidly expanding population.

Recent federal stimulus spending addresses some pressing repair needs for transport- and water-related systems and provides seed funding for high-speed rail in important travel corridors, as well as new energy infrastructure. But recession-busted government budgets, entitlement and defense expenditures, and ballooning health care costs push infrastructure down most political priority lists—leaders continue to procrastinate when it comes to new investments as stressed taxpayers balk at more spending.

A Path Forward

Infrastructure 2010: Investment Imperative warns that further delay risks impeding sustained economic recovery and means losing additional ground to countries in Asia and the European Union. These nations continue to implement long-range programs to integrate rail, road, transit, airport, and seaport networks to serve major economic hubs, employing state-of-the-art technologies and systems. Despite coping with recessionary fallout, they can front-load stimulus spending on national and regional infrastructure initiatives already underway—expanding high-speed rail networks and expediting energy and water projects.

In the absence of immediate funding solutions, the Obama administration takes some important initial steps to break down planning barriers between federal agencies responsible for infrastructure-related programs—departments of Transportation, Housing and Urban Development, Energy, and the Environmental Protection Agency. This more concerted policy-making approach could lead to developing national and regional strategies for helping America’s primary metropolitan areas cope with urbanizing suburbs, traffic congestion, and aging or inadequate water, sewer, and power systems. But more needs to be done.

Infrastructure 2010 recommends that government officials and policy experts take effective action, including the following:

- **LEVEL WITH THE AMERICAN PEOPLE** about how the country is falling behind other economies as a result of underinvesting in infrastructure, and explain the true costs of making required upgrades and building new systems.
- **DETERMINE A NATIONAL VISION** for infrastructure improvements that supports the viability of the nation’s key metropolitan areas and national gateways—the places that increasingly concentrate economic activity and propel growth.

- **MOVE TOWARD MERIT** rather than formulas in allocating federal funding to state and local governments for infrastructure, and encourage integrated infrastructure, environment, and land use planning.
- **ESTABLISH A NATIONAL INFRASTRUCTURE BANK**, modeled on Europe’s success, which can help promote more investment-grade decision making and attract more private capital into infrastructure investments.
- **RAISE REVENUES THROUGH USER FEES**, not only to pay for improvements and upgrades, but also to help gain economic efficiencies and environmental benefits through encouraging changed behaviors—less driving, greater water conservation, and reduced per-capita energy consumption.

Addressing the Water Challenge

While transportation-related issues and energy needs typically dominate infrastructure agendas, ensuring water availability and maintaining water quality also require immediate attention to manage supply and demand. No one can take water for granted. Every U.S. region—including fast-growing metropolitan areas in arid western states and established cities in more fertile zones—faces costly challenges to husband and deliver this precious and essential resource. The federal government as well as state governments must consider how to allocate supplies among competing users—residential, industry, and agribusiness—as the impacts of climate change and increasing population accelerate the urgency of dealing with the water challenge.

Revamped approaches and implementing solutions are necessary, including the following:

- **REPAIRING AND MODERNIZING OUTMODED SYSTEMS** to reduce leaks in water delivery networks and stem declines in water quality from failing sewage treatment plants.
- **DEVELOPING COLLABORATIVE REGIONAL STRATEGIES** to protect supplies across multiple states and varied local jurisdictions.
- **EMPLOYING PROVEN LAND USE TECHNIQUES** to reduce stormwater runoff and capture groundwater to replenish depleted aquifers.
- **USING INNOVATIVE RECYCLING TECHNOLOGIES** in development projects and for retrofitting existing buildings.
- **FARMING LESS-WATER-INTENSIVE CROPS** and planting less-water-dependent landscaping.
- **IMPLEMENTING CONSERVATION-oriented irrigation systems.**

Internationally, few countries escape water-related challenges. Australia implements innovative adaptation and conservation schemes to deal with parching drought. Many European countries fail to provide reliable water quality, India struggles with inadequate systems, and China copes with contamination and pollution in its water supplies, the result of its break-neck industrialization pace.

Changing How We Pay

How to pay for infrastructure remains a daunting challenge for most countries, particularly the United States, where decades of underfunding now force a massive catch-up effort by deficit-



constrained federal, state, and local governments. Unfortunately, political will appears in especially short supply to tackle mounting problems as cash-strapped households and businesses could buckle under higher taxes. Temporary jobs-based stimulus injections can't address long-term funding of integrated transport networks, power grids, and water systems.

The likely future funding course involves raising revenues from more and higher user fees tied directly to providing necessary investment capital for infrastructure systems, rather than reliance on general taxes, which distort and hide costs from the public. More public/private partnerships can help finance infrastructure development and operate systems. A national infrastructure bank could also help align government and private investor interests, and attract greater private capital. Innovative tolling technologies and smart meters can help users gauge and manage expenses directly related to transportation, water, and energy, encouraging more efficient and less costly lifestyle and business decisions. In turn, enhanced revenue sources should help ensure that Americans have safe, vanguard systems to promote commercial growth and meet quality-of-life expectations.

The Investment Imperative

Investing in infrastructure—done well and strategically—can help ensure increasing prosperity and the rising standards of living that Americans have come to expect. Many countries around the world—China, India, and those in Europe—understand the infrastructure investment imperative and are working to build the transportation, water, and energy systems that will grow their economies for future generations. The United States must find the leadership, will, and resources to do the same.

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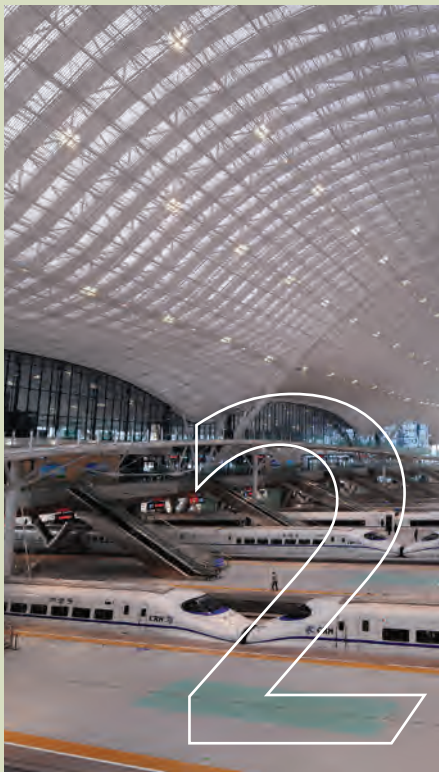
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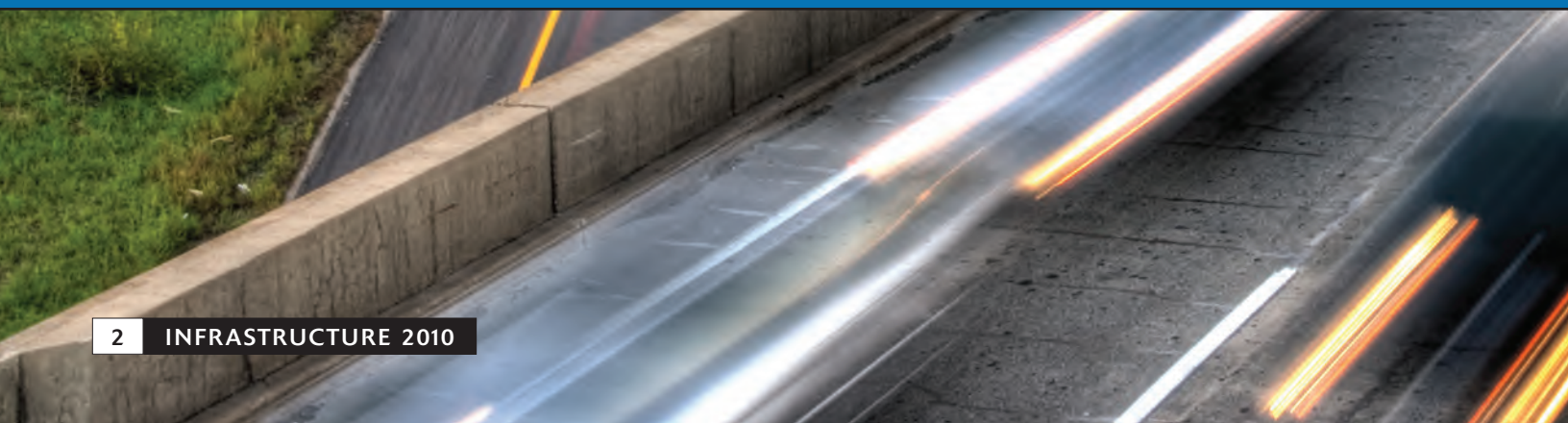
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INVESTMENT IMPERATIVE



An Economic





With the Minneapolis skyline in the background, cars speed by in rush-hour traffic on I-35 West. (Greg Benz-CarbonSilver Photography/Getty Images)

Imperative



A backburner issue four years ago when the Urban Land Institute and Ernst & Young initiated the annual infrastructure report series, the state of America's increasingly noncompetitive and deteriorating infrastructure systems—transportation, water, dams, and power—now register significantly greater political and public awareness. Mounting travel delays, more potholed roads and bridge closings,

and increasing sewage backups and water main breaks raise concern in metropolitan areas from coast to coast just as the country struggles to maintain economic competitiveness while emerging from deep recession.

Governors and mayors focus limited resources, including federal stimulus dollars, on repairs and improved maintenance, while many voices call for construction of new state-of-the-art ports, airports, and rail systems. The Obama administration and Congress advance high-speed rail and alternative energy solutions, and many states tackle water availability, quality, and conservation issues, but large deficits constrain options and inhibit the country's ability to formulate and fund a cohesive national infrastructure strategy.

America's global competitors also cope with recessionary fallout, but appear to advance more evolved infrastructure agendas as higher national priorities. In an urbanizing world, rapidly developing nations like China, Brazil, and India race to build new energy plants, high-speed transport, and water filtration facilities, while developed European countries upgrade existing systems and deal with shifting populations and immigrant flows in denser land use patterns. It's clearly no time for the United States to resist the obvious investment imperative—the opportunity costs grow and change accelerates in the global economic race.

FIGURE 1-1

Incentives and Spending Related to Infrastructure in the 2009 American Recovery and Reinvestment Act

Infrastructure Sector	\$ Billions	% of Total ARRA Spending
Transportation	48	6%
Energy	70	9%
Water	15	2%
Infrastructure Total	132	17%
ARRA Total	787	100%

Source: American Recovery and Reinvestment Act of 2009.

A Strategic Necessity

When it comes to infrastructure, the United States finds itself between a rock and a hard place. Economic fallout, competing priorities, and sticker shock prevent the country from aggressively addressing a slow-motion meltdown, the consequence of underinvesting in transport, water, and other networks for the past 30 years. Struggling with enormous public and private debt, the nation is limited in its ability to tackle an escalating and expensive rebuilding challenge. “We’re stalled, and in the meantime we’re operating on failing systems.”

U.S. leaders and policy makers must chart a new direction—spending available resources wisely and strategically. They must help Americans recognize that the nation’s relatively affluent standard of living cannot be sustained on infrastructure systems planned and built during the mid-20th century, when the country had only half its current population.

The stakes are considerable. America’s future prosperity, world economic standing, and ability to accommodate 120 million more people by 2050 directly depend on bolstering its primary economic gateway cities and metropolitan regions, which produce 90 percent of national GDP. This challenge necessitates integrating housing, transportation, water, and energy with land use in a comprehensive and strategic way.

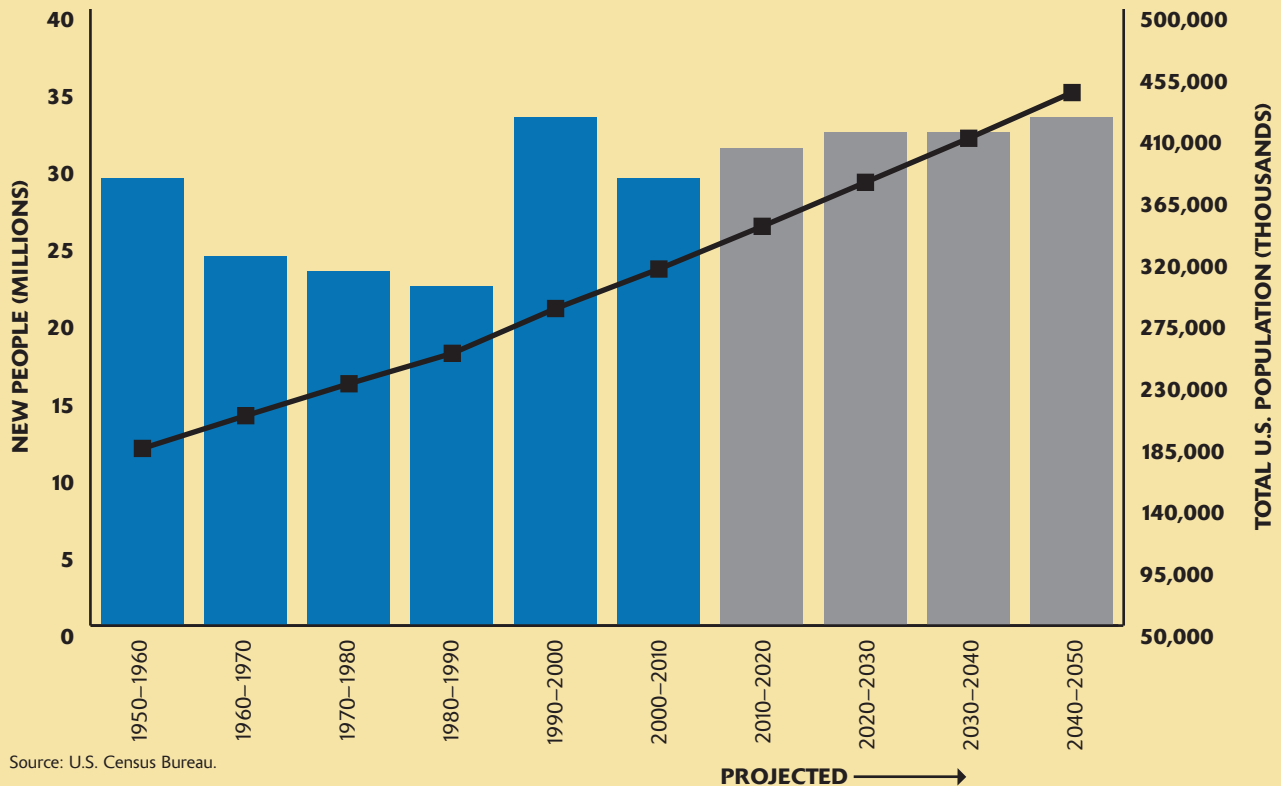
Delay promises only the prospect of steadily ebbing vitality. Indeed, the world order now begins to pass America by as countries in the European Union and Asia—in particular China—continue to implement policies to integrate rail, road, transit, airport, and seaport networks to serve major economic hubs, using 21st-century technologies and systems.

Making headway also requires “an extended conversation with the American people” about necessary change in how the country allocates government funding and resources, raises revenues, finances future projects, and pays for using and maintaining our road, transit, and water systems. Shell-shocked by economic tremors and enmeshed in costly wars, government leaders may understand the problems, but delay long-term infrastructure planning for quicker-fix stimulus bandages whose primary purpose is to boost jobs and relieve uncomfortably high unemployment numbers.

“At least people are talking about infrastructure and beginning to understand the depth of the problem—rhetoric slowly begins to catch up with reality.” But that’s not enough.

FIGURE 1-2

Every Decade between Now and 2050, the United States Will Add Approximately 30 Million People



Metropolitan Challenges

America is no longer an urban or suburban nation, but a metropolitan one. Inexorably and inevitably, traditional detached-house subdivisions have morphed into more urban environments—apartments and office buildings build up along retail boulevards in inner rings, regional malls transform into urban nodes, and town centers expand around new mass transit stations. America’s vast metropolitan regions take different shapes and forms across the country:

- **SUNBELT AGGLOMERATIONS** like Atlanta and Houston fill in dense development between original downtown cores and erstwhile edge cities. Denver reestablishes its downtown to anchor disparate urbanizing satellite centers.
- **IN THE NORTHEAST**, suburban fringes spread well beyond major 24-hour cities—Boston, New York, and Washington, D.C.—merging into a vast megalopolis.
- **SOUTH FLORIDA AND SOUTHERN CALIFORNIA** coalesce into expansive regions of interconnected subdivisions and urban centers.

This varied metropolitan landscape has engendered a free-form, car-dependent pattern, heavily subsidized for decades by federal highway and water system funding and later fueled by easy credit in mortgage markets. Left in the wake of ongoing transformation and change is a slew of unsustainable costs and inefficiencies:

Multilayered Local Governments

Metropolitan sprawl spawned a crazy quilt of overlapping county, town, and municipal governments, not to mention school districts, all taxing local property owners and households to cover considerable overhead for basic services, including police, fire, teachers, and garbage collection. Competing jurisdictions in turn rob each other for precious tax base (typically shopping centers and retailers), destabilizing neighborhoods and commercial districts when businesses move out for better deals. This chock-a-block local governance structure not only perpetuates highly inefficient bureaucracy, but also works against effective regional planning for delivering infrastructure and related services.

Aging and Inadequate Water and Sewer Systems

Taxpayers must pick up the considerable tab for repairing now-aging water pipes and sewers laid a generation ago over long distances to supply sprawling subdivisions. Many mains and sewage treatment plants constructed with federal Clean Water Act monies are reaching the end of their life cycles and require major upgrades. Twenty percent of the nation's

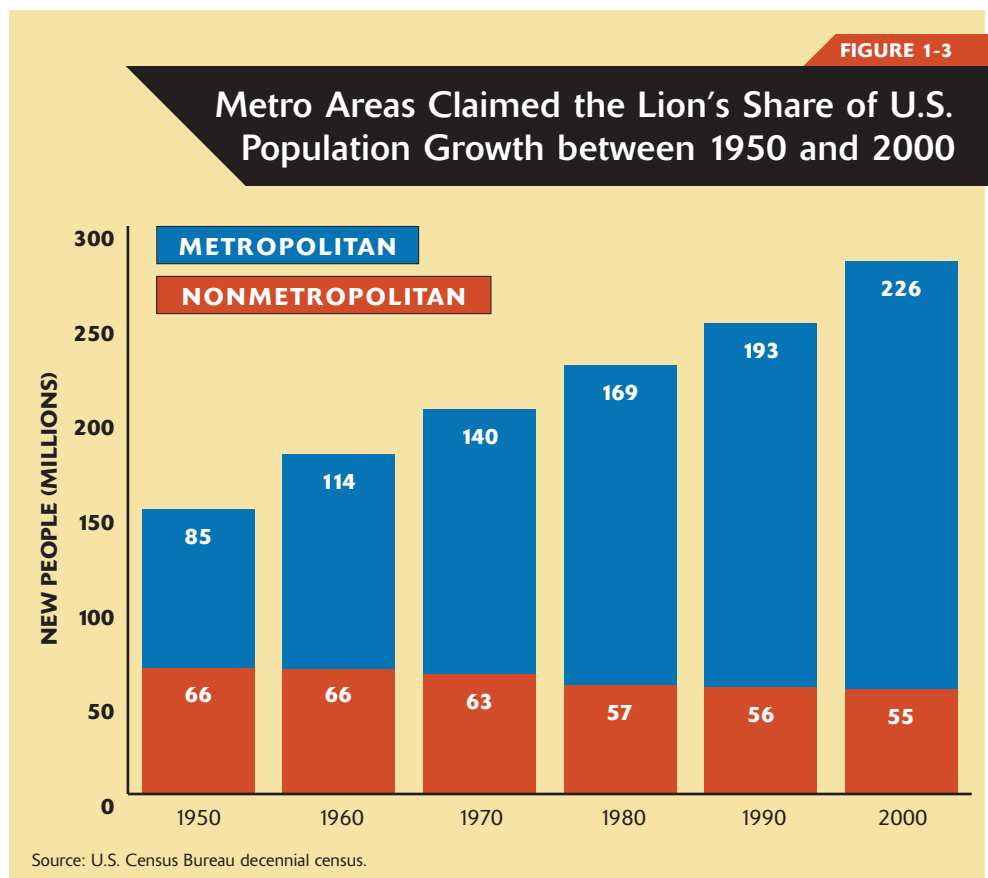
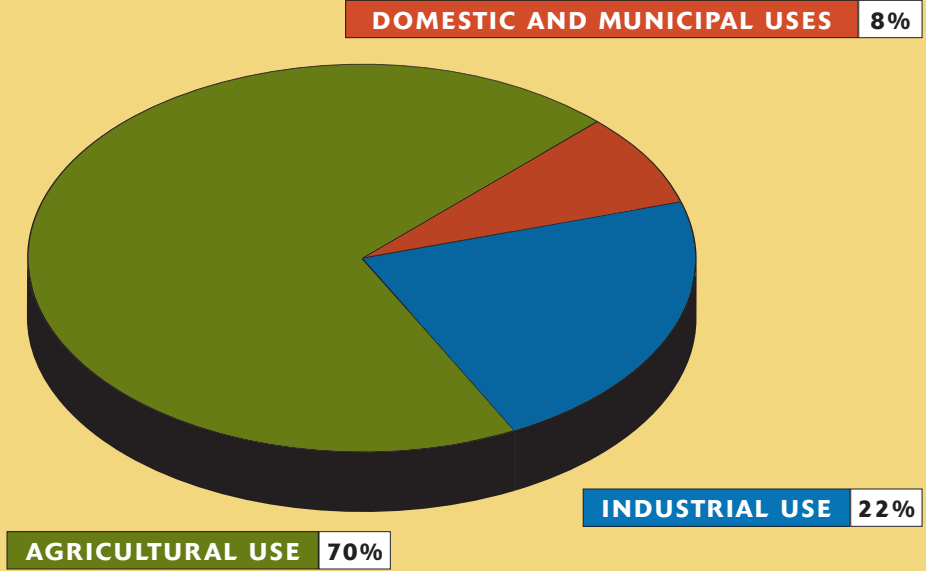


FIGURE 1-4

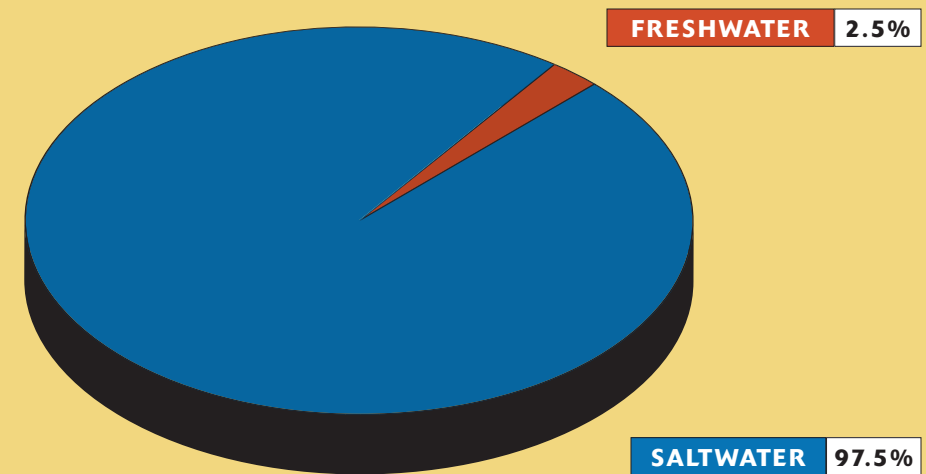
Most of the World's Freshwater Is Consumed by Agricultural Users



Source: World Water Assessment Program, 2002.

FIGURE 1-5

Most of the World's Water Is Saltwater



Source: United Nations Environment Program, 2006.

water treatment systems currently fail water drinking standards, and the price tag for water infrastructure alone is estimated to be \$10 billion to \$20 billion per year over the next 20 years.

Increasing Water Costs

Expanding populations and compromised or diminishing water supplies push up costs for pumping, storing, and replenishing reservoirs and aquifers in many regions. Climate change reduces snowpacks and enhances evaporation rates in arid, high-growth Southwest and West Coast population centers. Multiyear droughts recently threatened states in the Southeast—Atlanta is building new reservoirs after almost running dry during a multiyear drought. (Part Three of this report contains an overview of water issues facing 14 major metropolitan regions.)

Expensive Road and Bridge Repairs

Most highway and road building was heavily funded by federal and state dollars decades ago, when the country's economy operated on a high-octane growth curve, and now the bills come due with mounting repairs and resurfacing requirements on countless miles of serpentine asphalt. Either local, state, or federal taxes must increase to meet the burden or older streets will fill with potholes, raising safety concerns and threatening property values. Major bridges and interstate overpasses are approaching the end of their life cycles and will require extensive repairs or replacement. The Bay Bridge in San Francisco and Tappan Zee Bridge north of New York City are two examples.

Higher Driving Expenditures

All those roads and the absence of adequate mass transit options in many places orient most Americans toward car-dependent lifestyles. Americans spend an astonishing \$2.7 billion per day on their cars. These expenses (gasoline, auto loans, insurance, regular maintenance, repairs, parking) and time lost in frustrating traffic congestion are increasing to the point of shifting the cost equation in favor of living closer to work and embracing mass transit alternatives where available.

Escalating Homeowner Budgets

The housing market bust sinks home values closer to or below mortgage loans assumed by many borrowers across all income strata—U.S. homeownership rates could drop from nearly 70 percent, their 2007 peak, to close to 60 percent by the end of the decade. Beyond often unpalatable mortgage bills, owners of big houses on big lots face the brunt of increasing costs. Higher energy rates bite hard, increasing monthly utility bills. In parts of the country where water availability diminishes and water rates increase, maintaining lawns and gardens can turn into a pricey headache for cash-strapped homeowners. All these expenses come on top of backbreaking property and sales taxes in some localities, required in part to pay for necessary infrastructure improvements.



Shifting Sands

American Dream Redefined

This unsettling transformation of lifestyle economies and current financial plights gradually reorder personal priorities and promise to alter many Americans' perceptions of where and how to live "the good life." Reducing driving costs and cutting commutes orient people to consider living in more urban settings closer to workplaces and stores, and near transit stations. Reflecting its popularity, real estate near mass transit stops increasingly fetches premium pricing over drive-only neighborhoods. Recent ULI research, including *Beltway Burden* (for Washington, D.C.) and *Bay Area Burden* (for San Francisco), shows how the increased costs of car ownership and use largely offset savings from cheaper, suburban-edge housing.

Changing demographics also recalibrate where-to-live decision making. The two largest population cohorts—aging baby boomers and their now-young-adult echo boomer offspring—gravitate more toward cities or urbanizing suburb lifestyles. Many graying 50- and 60-something empty nesters consider downsizing and seek greater convenience since they are no longer raising kids in suburban school districts. Later-marrying young adults follow suit—they hope to build careers and find love in hipper urban environs.

Retrofitting the Suburbs

In the face of changing market

preferences and demographics, degeneration, congestion, and poorly planned infrastructure, many suburban communities are beginning to tackle the challenge of retrofitting themselves, offering lessons for other local governments, planners, developers, and commercial property owners. Challenges abound, including a lack of funding, inevitable dislocation, neighborhood backlash, and sheer inertia compromise. But inevitably, suburbs everywhere will confront hard decisions in coming decades about how to maintain their attractiveness and tax base in the face of inevitable change.

Large-scale transit investments help enable densification and the most dramatic makeovers, but ultimately confront daunting hurdles, including:

- negotiating transit rights-of-way through built-out areas;
- fending off lawsuits from disgruntled property owners;
- determining station sites and locating town centers;
- connecting stations to surrounding neighborhoods with pedestrian and bike access to reduce the need for parking and driving;
- refashioning street grids into more pedestrian-friendly designs; and
- most difficult of all—finding the money to pay for typically multibillion-dollar projects.

TYSONS CORNER TEST CASE

Characterized hyperbolically as “the most unpleasant place on Earth,” Tysons Corner, Virginia, a commercial/retail agglomeration outside Washington, D.C., is implementing a \$4 billion plan to overcome ever-mounting traffic congestion and address car dependence. The area features a staggering 167,000 parking spaces in blacktopped lots and concrete decks, which are being made over into more compact development around existing malls and hotels, new Metro train stops, high-rise apartment buildings, and parks.

LIGHTHOUSE IN LONG ISLAND

At the heart of Nassau County on Long Island, the owner of the New York Islander hockey team proposes to redevelop the area around its sports arena into a \$3.7 billion mixed-use town center with apartments, office buildings, stores, hotels, and a new central county transit hub. But the high-density “Lighthouse” project has drawn intense criticism from some locals who fear “Manhattanization” of the suburbs. Many leaders and groups, though, have

embraced the advantages of establishing an urban core to anchor nearby communities and support future growth. Virtually all surrounding districts were developed decades ago into mostly single-family subdivisions lined by typical boulevard retail strips. Several nearby towns now suffer from suburban degeneration—declining tax bases and failing school districts.

REGIONAL MALL MAKEOVERS

Other projects involve refashioning dead regional shopping centers and outmoded office or industrial parks into mixed-use urban nodes. Early retrofit projects such as Mizner Park in Boca Raton, Florida; Santana Row in San Jose, California; and Belmar (formerly Villa Italia shopping center) near Denver are now spawning others. In fact, eight of 13 regional malls in suburbs surrounding Denver have undertaken or announced retrofit projects, including housing, walkable street grids, and light-rail stations.

Two of the most successful regional malls in the Southeast—Dadeland in Kendall (Miami) and the Perimeter Center, north of Atlanta—collaborate with planners to reconfigure into more mixed-use environments. Dadeland is integrating into a surrounding streetscape and Perimeter incorporates residential towers with proximity to MARTA subway lines.

TRANSFORMING STRIP DEVELOPMENT

Form-based codes and planning guidelines, like those developed for Columbia Pike in Arlington, Virginia, can help resuscitate one-dimensional, strip-retailed road corridors and encourage mid-rise apartment development above and behind streetfront stores served by new mass transit lines.

BACK TO NATURE

Some communities are transforming abandoned malls or grey-field sites into parks and restored nature preserves to serve neighborhoods and deal with stormwater runoff.

In Northgate, Washington, developers turned a mall parking lot into condos, seniors’ housing, and a light-rail station. The property is relandscaped with wetlands.

Phelan Village in Minnesota reclaims a failed shopping center and turns cracked blacktop into wetlands and a lake recreation area, serving an adjacent housing development.

Columbus, Ohio, officials plan to redevelop an abandoned regional mall into a park, ringed by housing, restaurants, shops, and office buildings.

Enterprising Gateways Take the Initiative

The nation's major gateway cities are facing infrastructure woes and budget crises. But the good news for pedestrian-friendly, 24-hour cities is that they have well-designed infrastructure in place, which can efficiently serve dense populations. "You can improve on what already exists, instead of building new, costly projects to places with less capacity." The bad news is that much of this infrastructure desperately requires hundreds of billions of dollars in refurbishment and replacement, which budget-busted governments cannot fund. Among the most pressing big-city concerns: 100-year-old water pipes rusting their way toward oblivion, pre-World War I subway tunnels requiring buttressing and new tracks, and critical roadways needing dramatic overhauls. Largely driven by strong local leadership, some cities are using infrastructure to prepare for the next 50 years:

- **BOSTON COMPLETES THE BIG DIG**, cleans up its harbor, builds new bridges, and finishes a new airport/downtown tunnel.
- **CHICAGO UPGRADES ITS TRANSIT AUTHORITY**, expands airports, and incorporates green building standards.
- **NEW YORK CONSTRUCTS NEW COMMUTER TRAIN TUNNELS** and a downtown rail station, while expanding several subway lines.
- **SEATTLE PREPARES TO DISMANTLE** its downtown overpass—the Alaskan Way Viaduct—and reclaim its waterfront district, taking cues from San Francisco's refashioning of the Embarcadero.

But these important gateways, which dominate their regions, continue to suffer from outdated federal programs, which largely fail to integrate national transport planning with housing, energy, and environmental policies. Shortfalls in funding and a lack of coordination threaten to undermine these cities' competitiveness and ability to accommodate expected population growth as well as short-circuit the flow of commerce through increasingly congested metropolitan areas.

Recognizing True Costs

After years of subsidizing and effectively hiding the real expense of building and maintaining infrastructure from users and taxpayers, government leaders now wrestle with whether and how to pay for necessary massive infrastructure improvements at a time when the public calls for belt-tightening. Officials reflexively seem to resist leveling with Americans about the "true costs" of infrastructure and have trouble framing infrastructure programs as investments to ensure future economic growth. Chastened by current economic doldrums and taxpayer distress, they remain averse to linking costs for infrastructure development and maintenance directly to funding mechanisms like tolls and fees. And they consciously avoid jolting voter psyches, even if new user fee policies could be phased in and arguably would lead to lowered overall costs, greater efficiencies (including less congestion), increased conservation, and innovation.

Despite the National Highway Trust Fund nose-diving into insolvency, Congress delays action on raising revenues to help pay for roads and transit either through a gas tax hike or user fee initiatives like tolling interstates. In fact, legislators haven't raised the federal gas tax since 1993.

Establishing a national infrastructure bank, based on Europe's successful model for financing large-scale projects and attracting private capital to support national economic goals, is only starting to interest lawmakers. In the meantime, inertia has its own price: "The more you let things go, the more expensive the costs to fix and rebuild."

Some Signs of Progress

Against this tide, President Obama and Congress allocated \$8 billion in 2009 stimulus dollars for initial funding of regional high-speed rail lines. This \$8 billion sounds like a lot, but it won't go far—it would cover less than 20 percent of the cost for connecting cities in California alone. But at least the country has launched an important passenger rail initiative, and the USDOT is using the program to expand merit-based grant programs.

Some local leaders, meanwhile, have successfully made the case to build new transit systems. From Denver to San Diego, Phoenix, and the Twin Cities, mayors, local councils, and county executives unite to encourage, push, and cajole the public and state leaders to invest in light rail, commuter rail, and bus rapid transit. They argue cogently for how more integrated transit and road networks can promote regional economic growth and help reduce traffic delays. Since 2009, voters nationwide have approved 70 percent of transit-specific referendums, involving dedicated tax increases.

Nonprofit groups are also pushing for change. Groups like Building America's Future—led by California Governor Arnold Schwarzenegger, Pennsylvania Governor Ed Rendell, and New York Mayor Michael Bloomberg—step up advocacy for infrastructure funding and reforming national policy. Transportation for America also helps educate the media and the public about the real costs of maintaining competitive infrastructure.

Following San Francisco's lead in transforming the Embarcadero, Seattle plans to redo its downtown overpass, the Alaskan Way Viaduct. (AP)



Inevitable Dislocation

On top of contentious budget issues, virtually no official wants to confront the dislocation involved in building new infrastructure corridors for rail, transit, and power lines through existing neighborhoods in major metropolitan areas. It was relatively easy to bulldoze the interstates through mostly greenfields back in the 1950s and early 1960s. But retrofitting built-out metropolises to accommodate new mass transit and passenger rail routes or power grids from solar and wind fields will mean scarring some areas and choosing winners over losers. Investments that are needed for the greater good can easily be mired in costly litigation delays over eminent domain and property rights.

In Texas, for example, protests recently sidelined an ambitious superhighway rail-freight corridor. Electric utilities across the country grapple with where to locate pathways for new power lines to meet renewable energy goals.

Vice President Joe Biden stands behind President Barack Obama as he signs the 2009 economic stimulus bill. (AP)



Assessing the Scorecard

Infrastructure 2009: Pivot Point included a scorecard to assess how the U.S. government is addressing the country's infrastructure needs. Primary recommendations in 2009 were the following:

- **FOCUS STIMULUS FUNDS** into refurbishment and repairs;
- **INCREASE REVENUE** by beginning to raise the gas tax and allow more tolling;
- **APPOINT A DIVERSE NATIONAL COMMISSION** to formulate a long-term national infrastructure strategy;
- **INTEGRATE FEDERAL POLICY**, linking transport policy to energy, environment, housing, and land use initiatives;
- **CREATE A NATIONAL INFRASTRUCTURE BANK** as a true, merit-based underwriting institution; and
- **PASS NEW FEDERAL SURFACE TRANSPORTATION LEGISLATION** that is more integrated and multimodal, and that shifts funding from formulas to merit

To date, here's how we rate progress:

Stimulus: Strong Fix-It-First Focus

Funding from the 2009 federal stimulus bill (American Recovery and Reinvestment Act) focused on creating jobs and priming a sick economy, boosting badly needed fix-it-first projects—potholed roads, corroding bridges, and broken sewer pumps. Allocated mostly through existing federal program silos to states and then down to localities, about \$132 billion of the original \$787 billion in stimulus headed into infrastructure.

In spending the money, the Obama administration tries to encourage “have-your-cake-and-eat-it-too projects,” which offer game-changing improvements like high-speed rail, but struggles with the “slippery slope” of spending on disaggregated schemes and the absence of well-integrated regional infrastructure plans. Although “stimulus has plugged some holes and maybe helped with backlogged projects, it has little long-term impact or solutions.” Unlike the United States, China could pump its stimulus directly into national priorities, including bullet trains, because projects are either on the drawing board or underway.

Stimulus money also provides an opportunity for the administration to experiment with new, merit-based approaches to awarding transportation dollars. But the public's concern about the size of the overall U.S. stimulus package and rising government deficits probably hasn't helped the immediate case for greater infrastructure funding: “It's an example of, ‘Be careful what you wish for’—after all the bailouts, we know what a trillion dollars is and there's no appetite to spend it.”

Formulating National Infrastructure Policy: Initiating Dialogue

Beset by problems on all fronts, the Obama administration manages to initiate a national dialogue on the links between state-of-the-art infrastructure and the nation's future economic health—highlighting the benefits of high-speed rail and power grids for clean energy sources. Some progress

FIGURE 1-6

Innovative Transportation and Finance Programs in the 2009 American Recovery and Reinvestment Act

Program	ARRA Amount	Description
High-Speed Rail	\$8 Billion	This program employed a competitive application process to award federal funding for commuter and high-speed rail investments around the country.
TIGER (Transportation Investment Generating Economic Recovery)	\$1.5 Billion	TIGER awards grants of \$20 million to \$300 million to transportation projects that meet job creation, stimulus, and sustainability and livability criteria. As a mode-neutral, competitive program, TIGER provides a model for merit-based federal funding of future transportation investments.
TIGGER (Transit Investments for Greenhouse Gas and Energy Reduction)	\$100 Million	TIGGER provides discretionary grants to public transit agencies for capital investments that reduce energy consumption or greenhouse gas emissions of public transportation systems.
Build America Bonds	No Limit	This program authorizes state and local governments to issue taxable Build America bonds to finance capital expenditures. Governments receive a direct federal subsidy payment equal to 35 percent of the interest paid to investors.

Source: American Recovery and Reinvestment Act of 2009.

also occurs in focusing states and local governments on integrating goals for economic competitiveness, livability, and sustainability into requests for federal transportation funding.

But the country remains a long way from enacting and executing any meaningful new infrastructure policy to address increasingly complex issues involving built-out metropolitan areas, housing for an expanding population, rising energy costs, more limited water availability, and traffic congestion. “We’ve essentially punted.” The sharp partisan divide between Democrats and Republicans in Congress helps to short-circuit discussion about possible solutions. “It’s like going to two doctors—one says surgery and the other says exercise, but neither offers anything in between.” The ongoing impasse probably serves the purposes of both sides, since neither party can resolve the seemingly insurmountable how-to-pay issues.

Generating New Revenues: No Progress

Efforts to raise gas taxes or impose new user fees like tolls and mileage charges careen into recessionary realities. “That’s toxic talk for politicians,” even if road maintenance schedules fall further behind and some transit projects get mothballed. Stimulus funding doesn’t address the insolvency of the Highway Trust Fund, which remains the primary revenue source for transportation upgrades.

Ultimately, governments (federal, state, and local) must establish and phase in infrastructure revenue mechanisms that directly link amount of use to user cost in order to give drivers, businesses, consumers, and developers signals to adjust behaviors and operate more efficiently. Free roads and free parking encourage more driving, congestion, and emissions. Cheap water enables big lawns and long, hot showers in many regions where limited water resources can’t sustain current consumption levels. At the same time, the U.S. government starves for funding to build modern, multimodal transport systems as existing roads and bridges deteriorate and water main leaks increase. “The current course is quite simply untenable.”

Silo Busting: Some Positives

Interviewees praise Obama administration efforts to develop environmental, housing, and transportation policies in concert. Through the Partnership for Sustainable Communities announced in June 2009, the secretaries of key federal agencies—HUD, EPA, and DOT—have formally agreed to work together and take a more thoughtful approach on initiatives involving sustainable communities and economic productivity. The agencies are developing specific plans and budget programs to increase coordination and strategic reinforcement of objectives. “This is an important change” that could portend “the beginning of silo busting,” knocking down hurdles that prevent integrated regional land use planning.

Despite these advances, silo-think is far from dead—many federal funding formulas continue to segregate grants into separate buckets for specific road, transit, water, and housing projects. As a result, housing authorities, transit agencies, and transportation departments across the country still do their own thing instead of pooling resources and developing regional solutions and priorities. Metropolitan planning organizations remain largely ineffective.

New Transportation Bill: Gridlock

Reforming infrastructure and transportation funding is low on Congress’s priority list. Jobs, wars, deficits, health care, and homeland security—just to name a few contentious issues—capture more attention. In particular, lawmakers sidestep consideration of the federal transportation program. Efforts to shore up the Highway Trust Fund with general revenues will continue, but the sketchy economy makes meaningful transportation reform—and especially tackling the dicey funding conundrum (higher taxes and/or increased user fees)—more difficult.

National Infrastructure Bank: Stalled

A national infrastructure bank could help entice badly needed private capital to invest alongside public funds on large-scale projects like high-speed rail, new seaports and airports, or electric grid corridors, but other than a few leaders, lawmakers have not taken it up in a serious way.



The Metro Bilbao, a rapid transit system, connects the Spanish city of Bilbao with the rest of northern Spain.

The Long Road Back

America's ongoing infrastructure dilemma encapsulates the country's struggles to sustain a powerhouse economy, overcome mind-numbing deficits, shake off state of denial about future costs, and break through inertia. The following is a roadmap to meet the challenges ahead:

Provide Straight Talk

Ever since President Carter's popularity-deflating "malaise" speech, U.S. politicians have avoided "we're falling behind and need to do things differently" orations—they realize "morning in America" plays better to voters than "evening approaches." But today's realities require a new, more assertive tack. The country's leaders have the responsibility to educate the public about the consequences of underfunding infrastructure, the need for setting national priorities, and the importance of taking action to ensure a brighter future.

Rebuild America

A call to action must follow. Americans hate to lose—the Soviets' Sputnik launch galvanized the nation into winning the space race. Why shouldn't competitive juices be aroused in efforts to sustain living standards and relative prosperity through innovation and engaging the country's best and brightest business leaders, engineers, and planners to advance solutions?

A major "rebuild America"—type investment initiative could both rebuild infrastructure and boost lagging employment. Some interviewees argue that such a jobs program could be patterned after the Great Depression—era public works initiatives that built the Golden Gate Bridge, Hoover Dam, rural electric grids, and other major projects. Rebuild America could identify and fund game-changing, multimodal infrastructure projects to help ensure future economic productivity while creating jobs.

Determine a Vision for Connecting America's Metro Areas

Building on the federal sustainability partnership, the White House should lead federal agencies—including HUD, EPA, Energy, and DOT—in efforts to develop in concert an integrated strategy for revamping intermetropolitan transportation networks, connecting the nation's gateway cities and metropolitan areas, and incorporating regional housing, energy, and water needs. Objectives should include reducing ground and air traffic congestion and accommodating anticipated population growth, "acknowledging and supporting the places that are most important to our economy." Crucial to success will be identifying corridors for separate freight and high-speed rail tracks as well as transmission lines for new renewable power grids.

Regions should be incentivized (through new funding mechanisms) to link into national networks and develop holistic, multimodal transport strategies (including subways, fast-track buses, light rail, and roads). These systems would serve pedestrian-friendly urban cores and urbanizing suburban centers as well as airports and high-speed rail terminals. Regional plans also need to provide for infill housing and recreational areas to accommodate population growth as well as ensure future water availability.

A Daunting Challenge: Reestablishing U.S. Rail Capacity

After a half century of neglect and near-dinosaur status, passenger and freight railroads look like a potential back-to-the-future solution for helping America overcome its looming mobility crisis. High-speed rail could take pressure off airports and road systems for regional intercity travel, and freight trains could help reduce truck traffic in major urban gateways.

Interest is certainly up. The Obama administration has made high-speed rail a key transportation priority. Congress is tuning in to high-speed rail, too. The 2009 federal stimulus bill included \$8 billion in competitive high-speed and passenger rail funding, with additional funding added in annual federal budgets. The House version of the next surface transportation authorization includes \$50 billion for high-speed and passenger rail over five years. Federal dollars are giving a boost to state and local initiatives, already underway, to build high-speed rail and commuter rail.

THE COSTS OF CONGESTION

Car dependence and ever-escalating driving delays in most large American cities have exposed the need for more passenger rail service to take the pressure off crowded interstates and clogged airports, which struggle to handle current traffic volumes. The urgency of addressing the issue becomes more apparent since the country's population will increase by 120 million over the next 40 years, with growth concentrated in the nation's primary urban centers and surrounding suburbs. All these people will want to move around and current systems won't be able to handle prospective volumes.

For transporting goods and supplying daily needs, trucks offer tremendous flexibility in point-to-point shipping, but they also contribute to near-gridlock conditions around major U.S. gateways, cause significantly more roadbed wear-and-tear than cars, and generate higher carbon footprints than other transport

FIGURE 1-7

Designated High-Speed Rail Corridors and the Northeast Corridor



FIGURE 1-8

Rail Corridors Funded by the 2009 Recovery Act

Regions and Lines	\$ Millions
West Region	2,942
California	2,344
Eugene-Portland-Seattle	598
Midwest Region	2,600
Chicago-St. Louis-Kansas City	1,133
Minneapolis-Milwaukee-Chicago	823
Cleveland-Columbus-Cincinnati	400
Detroit-Chicago	244
Southeast Region	1,870
Tampa-Orlando-Miami	1,250
Charlotte-Richmond-Washington, D.C.	620
Northeast Region	485
New York-Albany-Buffalo-Montreal	151
Boston-New York-Washington, D.C.	112
Brunswick-Portland-Boston	35
Philadelphia-Harrisburg-Pittsburgh	27
New Haven-Springfield-St. Albans	160
Other Awards	27
Iowa	17
Texas	4
Multiple (Planning)	6
Total	7,924

Source: USDOT awards announced January 2010.

modes. Of greatest concern, mounting traffic delays compromise regional productivity in the country's most important economic hubs and ultimately increase business and shipping expenses.

In Chicago, congestion costs the metropolitan area \$7.3 billion a year in wasted time and fuel while sapping nearly 90,000 jobs from the local economy, according to the city's Metropolitan Planning Council. And conditions promise to get much worse. The American Trucking Association predicts that ever-increasing cross-country shipping volumes by 2020 will put 25 percent more trucks on roads. Some heavily congested highways around Chicago, Los Angeles, and New York cargo centers already carry more than 20,000 trucks daily and those numbers could double over the next 25 years.

NEW ATTENTION TO RAIL

Given the stark challenges, it's not surprising that government and business leaders ponder rail solutions to offer some relief to constricted road systems and flight paths. High-speed passenger networks are getting attention as an alternative to regional inter-city travel.

The \$8 billion in 2009 stimulus funding for project seed money generated applications from around the country worth \$55 billion. Initial awards under the program went to investments in Florida, California, and Chicago, with the Northeast trailing in the race for ARRA dollars. Federal money rewarded Florida's advanced rail planning efforts, and California's ambitious plan to link San Francisco and Sacramento with San Diego and L.A., which got a \$10 billion boost in a 2008 state bond initiative. A no-brainer on paper for high-speed rail, the Northeast corridor is bogged down by inadequate coordination among train operators, and was largely passed by in the first round of federal stimulus funding.

Suddenly, America's long-discounted freight rail network is looking like a strategic asset for tempering growth in trucking and its attendant problems. Private investors are interested, too. Warren Buffett made a \$26 billion investment bet on the Burlington Northern Santa Fe Corporation, the nation's second-largest freight rail carrier.

STEEP COSTS

But two significant obstacles stand in the way of ramping up rail use in the United States: a lack of money and absent political will for expanding transport corridors through built-out metro areas. To put costs in perspective, the U.S. High-Speed Rail Association budgets a lofty \$600 billion for constructing and equipping a 17,000-mile (27,359-km) national high-speed rail system over 20 years. A line linking major California metro areas could cost upwards of \$60 billion to \$80 billion alone and a dedicated corridor between New York and Washington, D.C., pencils out to \$10 billion. Obviously, the \$8 billion in stimulus funding won't go far, but it's a start.

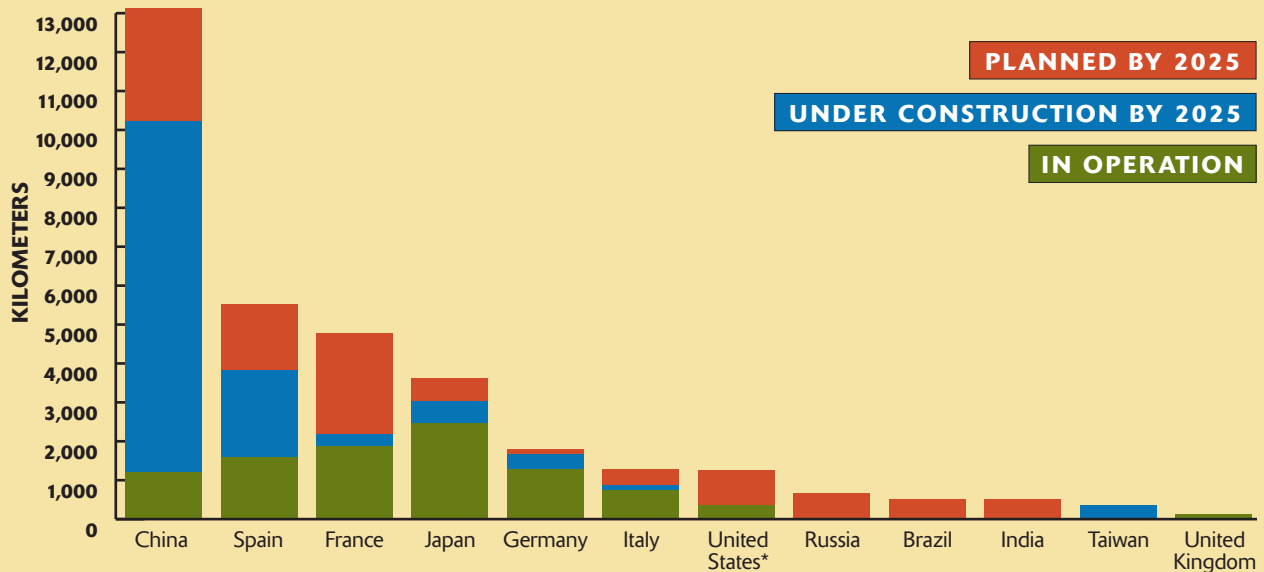
Many experts agree that high-speed rail funds should focus on linking regions and "supporting economic performance and tying into existing transit-oriented development." Topping the list is the Northeast Corridor from Boston to Washington, D.C.; the California line between San Diego and San Francisco; and a Midwest regional system anchored by a Chicago hub.

ALIGNMENT AND UPGRADE CHALLENGES

Besides the steep cost hurdles, fashioning dedicated rights-of-way for faster passenger and freight service runs headlong into formidable local jurisdiction and not-in-my-back-yard (NIMBY) resistance, especially in densely developed urban and urbanizing

FIGURE 1-9

International Investment in High-Speed Rail Is Strong



* High-speed rail is defined as lines or parts of lines that reach velocities in excess of 250 km/hour. The Acela route between Boston and Washington, D.C., is often not considered a true high-speed rail line because it never reaches speeds near those of other high-speed rail systems.

Source: International Union of Railways, 2009.

suburban areas. Required environmental reviews also add time and money to projects. Amtrak Acela trains, operating today between Washington and Boston, cannot reach technologically feasible speeds of 150 miles (241 km) per hour because they must share tracks with slower freight haulers. Widening rail beds for separate dedicated high-speed passenger and freight tracks would streamline service while meeting environmental and community challenges at the local level.

Even in the country's most business-friendly and regulation-free states, attempts to revamp transportation infrastructure can face intransigent opposition. An ambitious plan to develop a north-south truck-freight rail corridor from the Mexican border through Texas crashed into insurmountable NIMBY protests, forcing the state legislature to ditch the proposal.

FREIGHT BOTTLENECKS

Freight rail haulers, meanwhile, must overcome the vagaries of a century-old track network designed to deliver coal and steel to now-obsolete factories in the Midwest and ship finished goods from the center of the country to coastal cities for export. Today, the United States has gone from being the world's leading exporter to a net importer and remaining manufacturing shifts to new factories in lower-cost Sunbelt right-to-work states. The country's major seaports on the west and east coasts (Los

Angeles-Long Beach, San Francisco, Seattle, and New York-New Jersey) have become bottlenecks for huge volumes of imports destined for cross-country deliveries—only the recent recession has offered some temporary relief. Interviewees suggest that “the system needs a total redesign from the inside out” to support future needs.

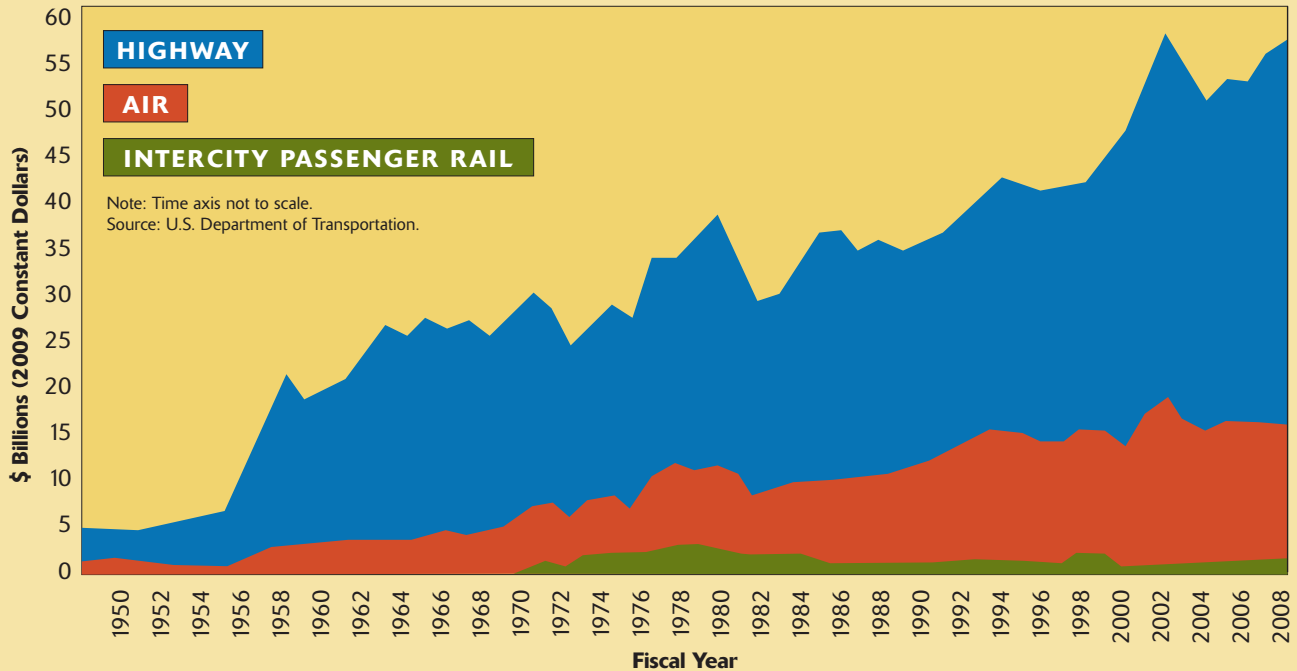
Among transportation planners, appreciation is growing for rail over trucks to solve congestion issues. “Maybe we can fix the work commute if we can take more trucks off road,” says an interviewee. “Since freight shares rights-of-way with passenger trains, it becomes a passenger versus freight battle. But then you don't need to spend as much on high-speed rail.” One way or another, solutions cost money and create winners and losers.

INTERNATIONAL INTEREST

While the United States struggles to plan and fund high-speed rail, other countries are plowing ahead. China, which spent \$8 billion on high-speed rail in 2009 alone, will have a total of 42 high-speed lines in operation by 2012. Spain's AVE train system now links Málaga and Madrid, a journey that once took 24 hours, in just 2.5 hours. In total, Asian and European countries are doubling high-speed rail capacity to close to 13,000 miles (20,921 km) by 2019.

FIGURE 1-10

A Need for Balance: Federal Investment in Intercity Transportation Has Heavily Favored Highways



Reform Federal Transportation Programs

Outmoded federal funding models might have served interstate and highway construction, but no longer address complex issues involving the growth and productivity of heavily developed metropolitan regions. Existing silo formulas and earmark allowances also compromise objectives for balancing road and transit spending as well as integrating economic development criteria, climate change goals, and livability standards.

Reformed transportation policy should shift funding from formulas, and use a competitive, merit-based process for allocating more transportation dollars. A new approach that provides **base funding** for localities to repair and maintain infrastructure, **bonus grants** for communities that meet guidelines for integrating infrastructure planning with housing and regional economic development, and national infrastructure **bank** loans to attract private sector involvement and finance projects of national or regional scope is needed.

Buttress Economic Gateways and Metropolitan Areas

Choices and decisions must focus priorities on initiatives that serve the most people and have the greatest impact on national economic growth. Getting the biggest bang for the buck requires strengthening the nation's large metropolitan areas, which concentrate population, business activity, and commerce and link directly into global pathways through international airports and seaports. In turn, these gateway cities must connect efficiently to key

regional commercial centers to support their growth. “In today’s global economy, when a country’s key gateways falter, the entire nation will suffer the consequences.”

Reconfigure Urbanizing Suburban Centers

If thoughtfully planned, emerging suburban town centers and districts surrounding regional malls can be refashioned into multifaceted 24-hour communities, including apartments, retail, office buildings, and parks. These urbanizing centers can support more dense residential development and anchor surrounding single-family neighborhoods. Mass transit networks—including subways, light-rail systems, and bus rapid transit—should connect them to primary business districts and intercity transport terminals for airports and high-speed rail.

Establish a National Infrastructure Bank

Look at Europe’s success. Established in 1958, the European Investment Bank (EIB) finances \$64 billion in projects annually across the continent, helping modernize seaports, expand airports, build rail lines, and reconfigure city centers. Few EIB projects have ever defaulted—borrowers repay EIB loans, allowing the bank to continually relend the money. That’s arguably not a bad model for the United States, especially considering daunting funding constraints. Following the EIB model, a U.S. entity could carefully underwrite long-term loans (up to 40 or 50 years) and base decisions on a competitive, merit-based process. Private capital will almost surely follow infrastructure bank investments, jump-starting more public/private partnerships and augmenting funding sources.

Pay Differently


Paying for infrastructure systems must become more user-based to synchronize behaviors with costs and benefits and alter habits to gain efficiencies. Building and maintaining roads the way we have been doing—with inadequate gas taxes, supplemented with additional revenues from general funds—hides the true costs from drivers and serves to underwrite and encourage car-dependent, energy-intensive lifestyles.

Technologically feasible mileage fees, new toll systems, and congestion charges can tie vehicle use more directly to road maintenance and inform decisions about where and when to drive. Likewise, if governments stop subsidizing water rates, then homeowners and businesses will be more likely to conserve or make more economic decisions on how they use water. User-based funding schemes could lower general tax rates, pay for systems, and reduce overall burdens on those taxpayers who make more efficient lifestyle and business decisions. User fee systems could also help attract private capital to finance needed projects.

Celebrate Progress

Since many infrastructure improvements require lengthy investment periods and years of disruption, communities must mark project advances and point to future rewards. For generations, Americans have sought to perpetuate—and raise—the standard of living for their children and grandchildren. Investing in infrastructure protects that essential legacy.





The world's fastest high-speed trains—reaching maximum speeds of 245 mph (394 km/h)—sit in central China's Wuhan Railway Station. (AP)

Global Update





Countries around the world are employing a familiar strategy to fight off unwelcome recessionary shocks and aftershocks—print money and step up government spending targeted at job-creating infrastructure projects. Most of China's \$600 billion in stimulus funding will go to infrastructure over the next three years, and Spain plans to spend over \$20 billion (€15 billion)

Roads and bridges light up the night in Shanghai, China.

in 2010 alone. These short-term infusions are generally accelerating timetables for development initiatives already underway, or funneling money into planned and approved repair and refurbishments, which can be started and completed quickly.

But many revenue-poor governments are retrenching, with a circumspect eye on rising deficits. Some big plans get shelved or construction schedules are either delayed or lengthened. In general, nations gain some advantage where they fund long-term plans and strategies already in place. Governments without well-conceived national policies, exemplified by the United States, push dollars into the economy for jobs, but lose the opportunity to build new networks and systems.

Fast-developing countries with relatively healthy economies—notably China and potentially Brazil—enjoy twin advantages: they have cash flows to finance projects and can develop new networks using the most current technologies. Mature, long-industrialized European Union and North American countries must deal with costly retooling of aging and rapidly deteriorating systems as well as the political challenges of retrofitting new schemes on heavily developed and populated landscapes.

Europe, the U.K., Germany, Spain, France, Italy, the Netherlands, and other European Union members gain an edge on the United States by undertaking cross-border connectivity initiatives funded partly by the European Investment Bank. High-speed rail networks now link major European capitals and freight rail projects get a boost. Poorer EU

countries to the east and south—including Hungary, Slovakia, and Greece—concentrate on modernizing their water systems to EU standards; many still don't provide reliably potable tap water.

Canada copes with major funding gaps by focusing spending on streamlining national networks partly through a multiyear funding scheme called Build Canada. Australia takes the global lead on developing and employing water conservation systems and desalination technologies to overcome prolonged drought.

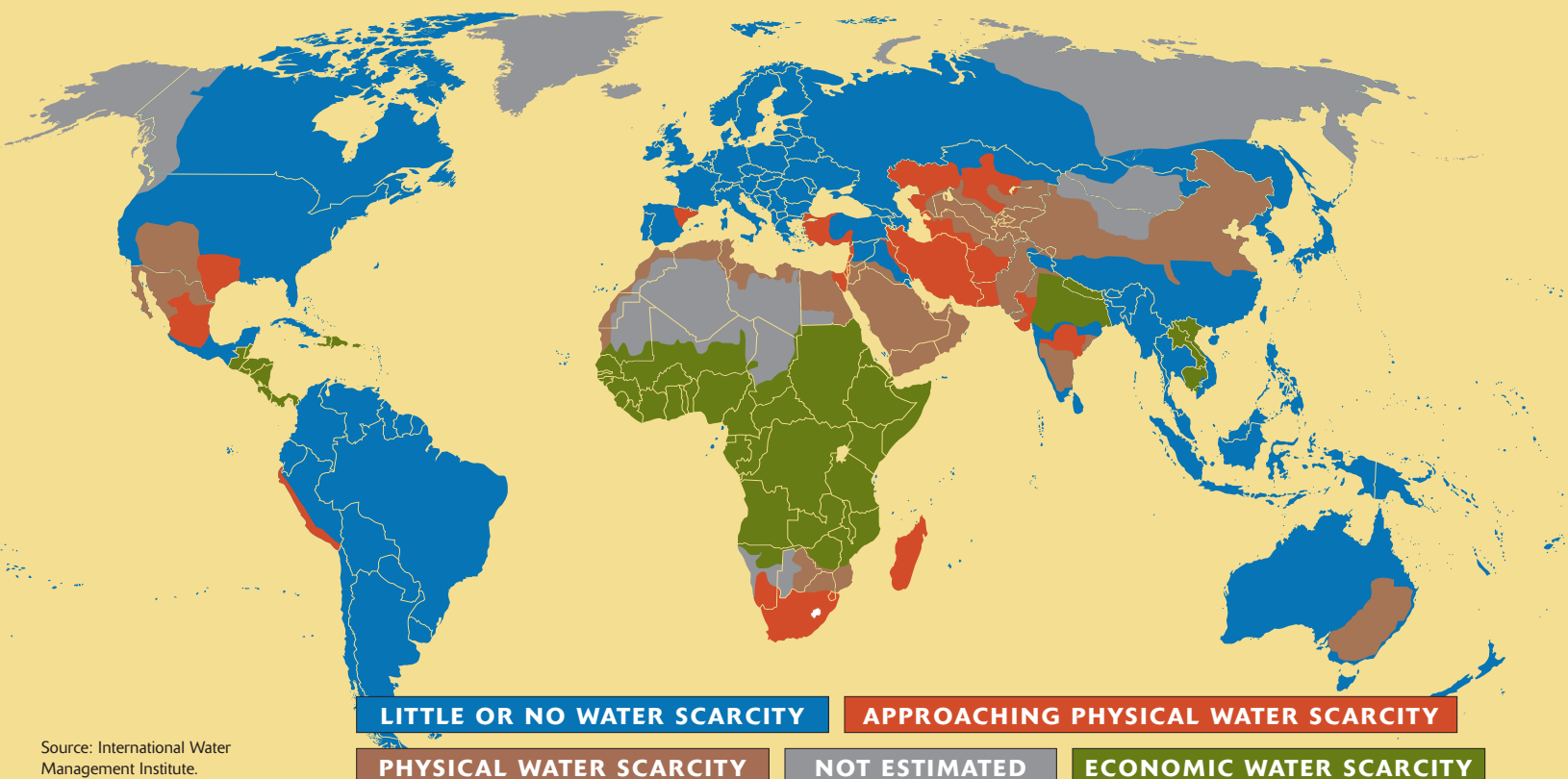
India suffers from climate change and drought conditions, which complicate progress in developing water delivery systems for many parts of the country. Longstanding corruption and political infighting also compromise India's progress in building new transport systems to support its burgeoning economy in one of the world's most populated and still impoverished nations. Japan faces a diametrically different problem: its state-of-the-art transport systems have more capacity than demand as its steadily graying population enters an expected period of sharp decline.

China

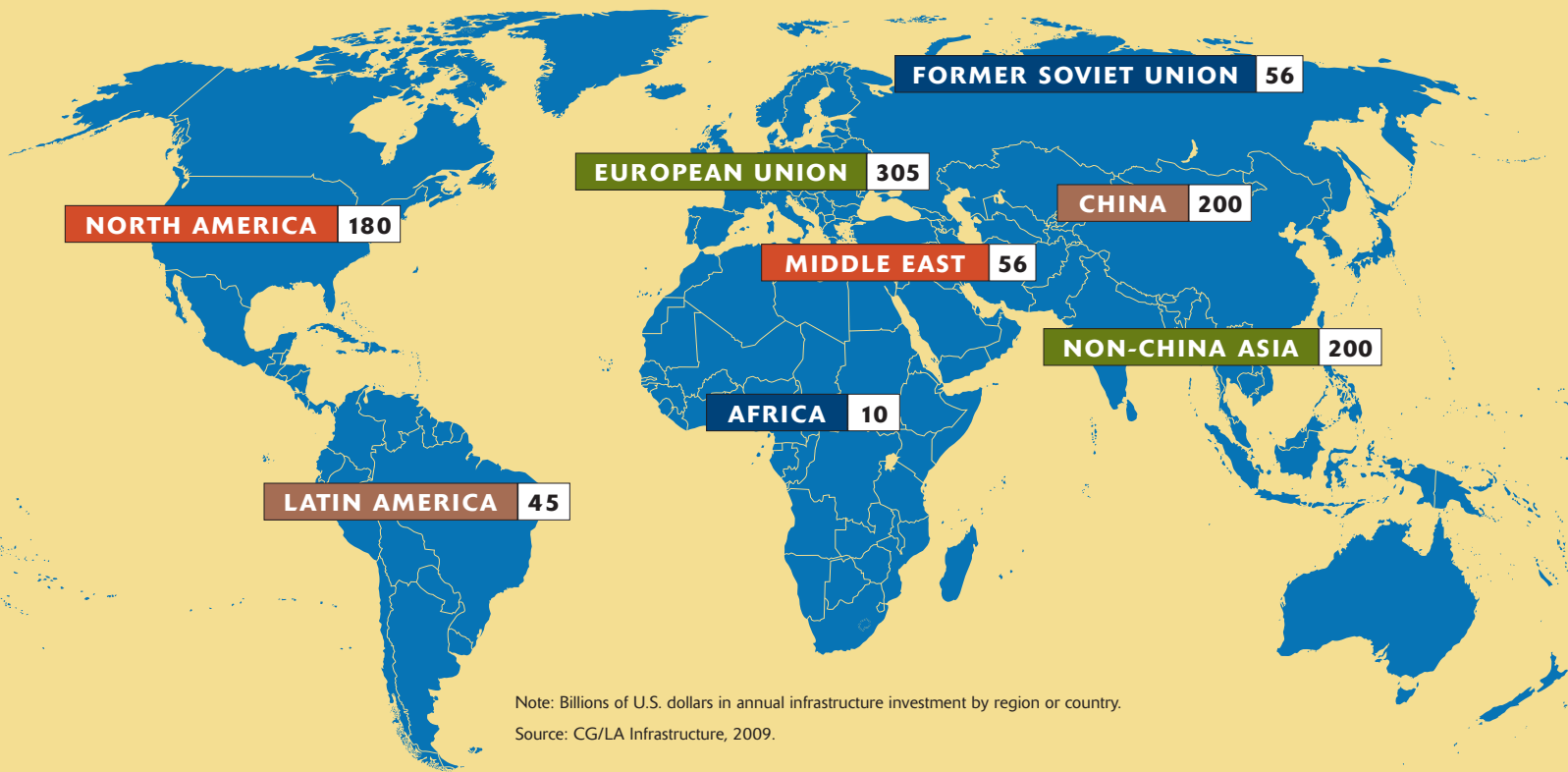
China leapfrogs the rest of the world when it comes to building modern transport infrastructure, investing hundreds of billions of dollars in new roads, dams, mass transit, high-speed rail, ports, and airports. Stoked by one of the world's fastest-growing economies

FIGURE 2-1

Water Scarcity Plagues Much of the World, and the Western United States



Asia and Europe Will Lead the World in Annual Global Infrastructure Investment Over the Coming Decade



and enabled by relatively cheap labor as well as peremptory government authority, the country pushes ahead at a breakneck pace.

The government has directed most of nearly \$600 billion in stimulus monies into large-scale infrastructure, particularly high-speed rail networks connecting primary cities. Government-owned enterprises build and operate many projects—they attract private capital and trade on stock exchanges. Overall, 9,941 miles (16,000 km) of new high-speed rail track will be completed by 2020, representing a staggering total investment of more than \$300 billion, including \$50 billion spent in 2009 alone. More than 100,000 workers are working on the Beijing-to-Shanghai line, which when completed will be the world's largest, fastest, and most technologically sophisticated bullet train route.

The country also continues to construct a more extensive national highway system than that which exists in the United States. In vast and expanding urban population centers, planners link new subways, light rail, and rapid bus lines to clustered housing developments and commercial/industrial cores, hoping to limit the impacts of increasing traffic congestion.

China has lagged badly in environmental responsibility, but now looks to catch up by addressing water, wastewater, and air-pollution/renewable energy issues. The country takes the world lead in developing solar and wind technologies as offsets to heavily coal-dependent power utilities and industries, and builds state-of-the-art wastewater systems. Beijing aims to reuse 100 percent of its wastewater by 2013. But large areas of the country with hundreds of millions of people remain without potable water.



India

Another emerging economic power, India could experience a slowing growth track unless more progress on modernizing backward infrastructure occurs. Ambitious plans to build 4,349 miles (7,000 km) of new roads annually run afoul of government bureaucracy and conflicts between state and national agendas. Land acquisition for projects must overcome major impediments—complex laws, poor title records, little transparency in pricing, and disputes over relocating landowners and compensating affected communities. Projects often run behind schedule and over budget.

Rapid population shifts into urban areas—forecasts predict 400 million more people living in India’s cities over the next 40 years—threaten to overwhelm lagging transit schemes and already crowded road networks. New transport projects typically bottleneck immediately on opening, while power grids can’t reliably handle surging demand from expanding businesses and a growing consumer class.

Rainwater collects beneath a section of metro line in New Delhi, India. (AP)

Water diversion and capture methods pit farmers and regions in ugly confrontations as sporadic rains lead to droughts in many rural areas, threatening food production. About half the country's billion-plus population still has no access to toilets or latrines. In response, the World Bank pledges \$4.3 billion to fund economic development, including rural water supply and sewage projects.

Recovering credit markets should help ease recent constraints on public/private partnership investments while the country continues to make strides expanding seaports and modernizing international airports in its gateway cities like Mumbai and New Delhi.

Japan

Japan has employed public works stimulus to boost its lackluster economy for close to two decades, building new roads and ultra-modern airports and expanding bullet train lines, which enhance already technologically advanced and widely admired systems. Now, this island nation faces a quandary—the economy remains in a funk despite the spate of spending, which not only generated huge government deficits, but ironically also overdeveloped infrastructure capacity. More ominously, low birth and immigration rates portend losses in population, graying demographics, and compromised economic growth—new high-tech airports now compete against each other to fill empty gates with flights. Aside from necessary ongoing infrastructure maintenance and upgrades, Japan doesn't need much of anything new for some time to come.

Skyscrapers tower over the trees in Tokyo, Japan.





South Korea

In 2005, then-mayor of Seoul Lee Myung-bak transformed a paved-over sewage canal into a popular four-mile (6.4-km) downtown riverwalk. In 2009, South Korea broke ground on a controversial \$19 billion “green” cleanup project touted to rebuild the country’s four longest rivers, improve water quality, control floods, and create new recreational areas. Opposition groups contend that planned dredging and damming could be an ecological disaster.

Also in the country’s pipeline of large infrastructure projects are a 93.2-mile (150-km) underground road network in Seoul budgeted at \$9 billion, a \$3 billion expansion of Incheon International Airport, and \$2.3 billion toward green energy initiatives. These projects represent South Korea’s ongoing commitment to advancing its transport and power systems—major cities already link together by high-speed rail and highways, and feature efficient subways. Incheon Airport serves more than 30 million passengers annually and rates consistently as one of the world’s best facilities.

Singapore

Singapore enhances its reputation for acclaimed infrastructure with completion of the Marina Barrage, a \$170 million, 1,148-foot (350-m) hydroelectric dam project that integrates flood control, green technologies, and recreation features. Twenty years in planning, the dam helps protect the low-lying island city-state from frequent storm flooding, creates a new inner-city freshwater reservoir, and provides attractive new recreation areas at the edge of downtown. The dam also includes a power station and solar plant. By stabilizing upstream waterways, the project enables new urban development (\$7 billion worth of construction is underway) in areas previously subject to severe flooding—Singapore averages 100 inches (254 cm) of rain annually.

Singapore’s Marina Barrage helps to manage excess precipitation, provide flood control, and enhance water supply and quality.

United Arab Emirates

Even in the midst of a financial crisis, Dubai continues to build more infrastructure, including metro lines (the first operating subway in the Gulf States), a new international airport, power plants, and desalination systems. Faced with the collapse of private investment, the government is trying to fill the gap with increased public spending on infrastructure projects.

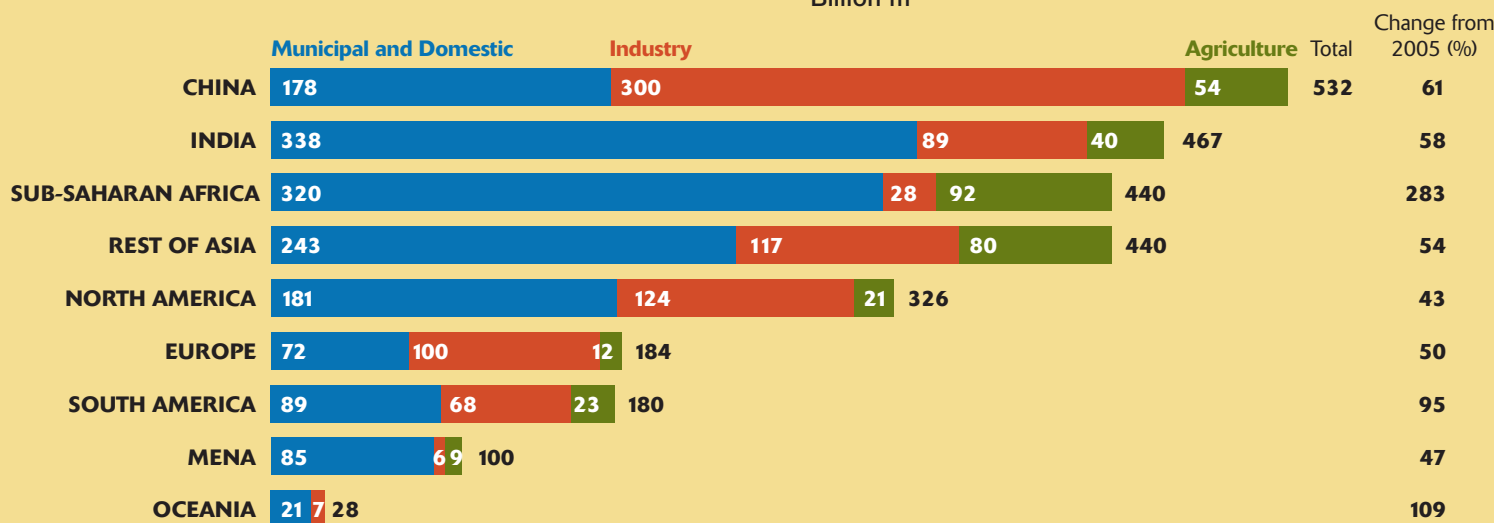
Abu Dhabi, the U.A.E.'s capital and wealthiest emirate and home to 95 percent of the U.A.E.'s oil reserves, fares better fiscally and continues its own infrastructure binge. The city



The Burj Khalifa in Dubai is currently the world's tallest building. (©Beatriz Pitarch)

Water Demand in China, India, and Africa Is Expected to Grow Rapidly

INCREASE IN ANNUAL WATER DEMAND, 2005–2030
Billion m³



Source: 2030 Water Resources Group, 2009.

is fighting congestion by implementing a 20-year master plan that includes 80.7 miles (130 km) of metro lines as well as 211 miles (340 km) of bus rapid transit routes and tramways.

The U.A.E.'s long-term challenge centers on providing enough water to sustain its ambitions for cementing its global status as the Gulf's finance capital, shipping hub, and resort destination of choice. Not only is water already a scarce resource in these desert states, but dependence on desalination results in unintended pollution of precious groundwater from brine infiltration. High energy loads from pumping water and operating desalination plants in addition to increasing commercial and residential demand require increased power plant construction, including consideration of nuclear and solar facilities.

But various power plant options each require water for operations. Out of necessity, the U.A.E. starts to focus on becoming a leader in recycling water, groundwater recharging, and old-fashioned conservation.

Canada

Canada mirrors the United States in struggling to overcome years of infrastructure underfunding and scrambling to deal with deteriorating transport systems and lost productivity from congestion, especially in its primary cities like Toronto. The Federation of Canadian Municipalities and the Institute of Public Policy peg the nation's infrastructure deficit at somewhere between \$112 billion (C\$120 billion) and \$187 billion (C\$200 billion), a sizable hurdle for a country of approximately 30 million people.

To fill part of the gap, the federal government has allocated \$30 billion (C\$33 billion) over seven years (2007–2014) focused on achieving three primary objectives: cleaner water and air, safer roads, and shorter commutes. A separate government agency, Infrastructure Canada, was established in 2002 to take the lead in determining national strategies, coordinate planning with



Pipelines in Australia transport water to a hydroelectric power station.

provincial governments, and seek additional funding from private capital in public/private partnerships. The department manages three funds that allocate to national highway systems, public transit, and drinking and wastewater projects.

In addition, the government has allocated \$11 billion (C\$12 billion) in stimulus funding for a range of infrastructure and green projects. “Some previously stalled,” “less sexy,” and “long-overdue projects”—like seismic retrofits for bridges in British Columbia—are now getting implemented. Finally, Ontario considers privatizing some government assets to close budget deficits.

Australia

Australia is expanding infrastructure refurbishing efforts with a \$17.6 billion (A\$20 billion) Building Australia Fund, initiated in 2009. According to recent Engineers Australia report cards, the country has made slow and steady progress during the past decade in upgrading dated rail, airport, and water systems—another evaluation will be issued in 2010. More than \$5.3 billion (A\$6 billion) in stimulus spending centers on modernizing rail networks in the six largest cities and the government makes a major push for internet access with a national broadband network.

Water and energy receive special attention—the drought-plagued nation undertakes public/private partnerships to construct desalination plants to serve its major metropolitan

regions, while setting a 20 percent renewable energy target by 2020. Dependent on coal-fired power plants and already ranked as one of the world's highest per-capita polluters, Australia looks to harness wind and solar technologies to supply power to the new energy-intensive desalination units.

Brazil

Brazil copes with difficult emerging market growing pains and the challenge of modernizing infrastructure fast enough to sustain booming economic growth and its higher-profile image on the world stage. Roads, rails, ports, airports, and energy transmission all need major attention.

Just weeks after Rio de Janeiro won its 2016 Olympics bid, much of the country plunged into an electric power blackout, despite major recent investments in upgrading transmission capacity. The government expects to invest \$800 billion into energy infrastructure over the next 25 years, building four nuclear reactors, large hydroelectric facilities in the Amazon, and other plants to meet mushrooming electricity demand. The country opened the world's first ethanol-fueled power plant in January 2010.

Transport systems present other challenges: traffic congestion plagues São Paulo and Rio de Janeiro, where subways are modern and well operated, but offer limited lines to riders. Intercity highways, meanwhile, are often poorly maintained two-lane roads, not remotely comparable to U.S. interstates or European motorways. A \$4 billion public/private toll road concession finances construction of an 84-mile (135-km) motorway from São Paulo part way to Rio and a \$19 billion high-speed rail line is planned to link the two big urban centers in time for the 2014 World Cup. The government actively seeks more private capital—thawing global credit markets increase expectations of significant foreign fund infusions and investments, although financing can be complicated by domestic borrowing rates and currency hedging issues.



Brazilian President Lula da Silva visits a thermoelectric plant in Cubatão that is expected to reduce pollutant emissions. (AP)

Mexico

One notable casualty of world economic distress has been President Calderón's signature \$270 billion six-year National Infrastructure Plan, which had kicked off in 2007, before the crash. The program counted on significant international private/public financing, which dried up in the global credit crisis. The government readjusts timelines and expectations, but continues to focus on hundreds of projects in multiple sectors—modernization of more than 12,427 miles (20,000 km) of roads, 932 miles (1,500 km) of new railways, port expansions, and water and wastewater treatment facilities, as well as energy exploration.

A new deepwater seaport and rail hub in Punta Colonet, 149 miles (240 km) south of the U.S. border, remains on the drawing board and would compete for Pacific Coast container shipping traffic against L.A./Long Beach, San Francisco, and Seattle.

European Union

Economic stimulus initiatives to create jobs push European nations to advance infrastructure project schedules—"they build in five years what they had planned to fund in ten." The three to five years of increased stimulus spending now underway will likely be "followed by a slowdown to focus on the deficits created."

Travelers are stranded in London's St. Pancras station during a major service suspension in December 2009. (AP)



European Union cross-continent network projects (Trans-European Networks, or TEN projects) for transport and energy provide ample shovel-ready opportunities. The EU provides \$630 million to member nations to spend on rail links between countries, including high-speed passenger lines. But like the United States, EU nations tend to direct most funds into maintenance and upgrades, starting projects as quickly as possible through “normal agency channels.”

Water availability is becoming a growing concern in southern Spain, where farmers battle developers over water rights and growing swaths of land are turning to desert. The country undertakes public/private partnerships to build as many as 18 desalinization plants.

Central Europe

In central Europe, funding pours into water and wastewater initiatives to address “huge leakage problems” and replace old systems. Companies and investors see big opportunities for public/private partnerships in the water arena—Italy, Greece, Poland, the Czech Republic, Slovakia, and Hungary all need sewage treatment plants and new water delivery systems. Most of these countries do not have reliably potable tap water.

United Kingdom

Heavily road-dependent and London-centric, the U.K. adopts a combination of large-scale and small-bore transport infrastructure initiatives designed to reduce congestion in and around the nation’s capital.

In 2009, tunneling began for the 73-mile-long (117.5-km-long) Crossrail project under London. Scheduled for completion in 2017, the much-anticipated line will connect Heathrow Airport on the city’s western fringe directly to the Canary Wharf business district and then extend to eastern suburbs. The new train system should help temper ring road and inner-city subway congestion as well as ease travel to Heathrow, the world’s busiest airport and Europe’s primary gateway. Budgeted at nearly \$23 billion (£16 billion), Crossrail is Europe’s largest construction project and the U.K.’s biggest since the monumental Chunnel rail tunnel under the English Channel linked England and France.

Although the U.K. has lagged Europe in building domestic high-speed rail routes, departing London Eurostar bullet trains now reach Brussels and Paris in about two hours, with service extending to Amsterdam. And the U.K. government is studying a proposal for a new high-speed line connecting London to destinations in the Midlands and Scotland.

Center city-to-center city trains reduce regional airline traffic and help restrain increasing flight and road congestion around Heathrow. Despite contentious protests from local residents, the government greenlights construction of a third runway at Heathrow and continues modernizing the airport’s terminals.

The government is also implementing a \$9.6 billion (£6 billion) program to refashion motorway hard shoulders for use in peak congestion periods, helping reduce traffic without necessarily widening roads in built-out suburban areas. London’s congestion pricing cordon raises revenues and constrains traffic growth, but performance is below original forecasts.

France

France injected \$1.21 billion (€870 million) in stimulus monies into its transport sector during 2009, and advances plans to double its sleek and heavily used high-speed rail system to about 2,500 miles (4,023 km) by 2020. The country's \$25 billion (€18 billion) rail strategy looks to shift more intercity travelers off roads and onto TGV bullet trains, and reduce short-haul airline flights, which clog Charles de Gaulle, Paris's international gateway airport. Four projects gain priority, reaching into regions not yet served by TGV trains, among the world's fastest: extension of the Paris to Le Mans line to Rennes in Brittany, a new line between the southern cities of Nimes and Montpellier, an extension of a Paris commuter line to Strasbourg, and a line from the Loire Valley to Bordeaux.

The government also aims to take the world lead on developing infrastructure to support use of electric and hybrid electric cars, giving a boost to the country's car industry (Renault steps up plans for electric car and battery factories) as well as meeting targets for carbon emissions reductions. A \$2.2 billion (€1.5 billion) program subsidizes installing car-charging sockets in homes, parking lots, and roadside sites. Charging points will become mandatory in all new apartment and office parking facilities. In addition, the government budgets \$6.6 billion (€\$4.5 billion) to develop a national broadband network.

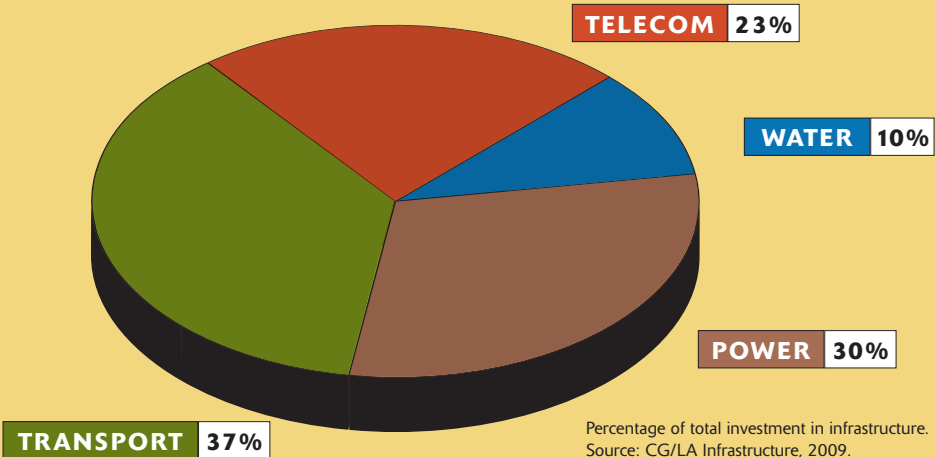
Paris's innovative bicycle-share rental system, designed to encourage bike trips over driving in the congested center city, has hit some speed bumps: About 80 percent of the original 20,600 bikes have been damaged or stolen.

Germany

A consortium of German industrial, energy, and finance companies pursues an unprecedented solar energy project, which would transport solar-generated electricity from state-of-the-art plants in Africa's Sahara Desert through new high-voltage transmission lines to

FIGURE 2-4

Global Infrastructure Investment Over the Next Decade by Sector





Germany and other European countries. Called Desertec, the \$556 billion (€400 billion) clean-energy scheme conceptually would supply as much as 15 percent of Europe's energy needs by 2050 and reduce carbon footprints. The companies—including Siemens, Deutsche Bank, and RWE—expect to take as long as three years to study feasibility and develop a concrete plan.

Russia

Volatile energy prices and credit gridlock have stymied Russian plans to increase spending on badly needed projects to replace or restore deteriorating Soviet-era infrastructure. You name it—roads, rails, seaports, airports, oil fields, water systems, and power grids—all require attention. Business and government leaders lament inability to address “limitless needs” and the ultimate economic drag. Corruption and weak project management expertise also increase costs and typically slow delivery of projects.

The country, nevertheless, moves to complete several major initiatives—two new highways from Moscow to Minsk and St. Petersburg, modernization of deepwater ports at Sochi and Arkhangelsk, and a new light-rail system in St. Petersburg to link into the city's metro and bus networks.

The controversial Nord Stream pipeline connecting Russian gas fields to Germany has moved forward with a blessing from Finnish environmental authorities. But central Europe's dependence on Russian gas supplies raises fears that Russia can exert political pressure and increase rates through threatened shutdowns or supply cutbacks, especially in winter months.

The new Russian oil export terminal opened by Prime Minister Vladimir Putin serves as a key gateway for Russian energy exports to Asian markets. (AP)



Sea and city meet along the Gold Coast in Queensland, Australia.



Water Woes



“When it comes to water, there is just no magic bullet.”

Perhaps no other infrastructure category presents the United States with greater challenges than water. Like roads and bridges, water systems once in place seem taken for granted—most Americans assume drinkable tap water will always be available and give little thought to how it gets into homes. People don't realize how water pipes, sewage treatment plants, and reservoir

dams can age and deteriorate surprisingly quickly—in less than an average person's lifetime. And no one wants to recognize that upgrading systems is extremely costly—in fact, many budget-constrained state and local governments postpone addressing problems that can stay all too easily “out of sight and out of mind.” As a result, over time more buried pipes leak, more underground mains break, and the costs for inevitable repairs or replacement only increase and may even skyrocket.

Relative to the price of electricity or gasoline, tap water typically doesn't cost much. Most water districts do not charge ratepayers full outlays for constructing and maintaining systems—federal and state grants typically helped pay for sewage treatment plants and water lines—and many communities subsidize water and sewage services out of general taxes, skimping on maintenance. As a result, businesses and households tend to use water inefficiently and don't conserve even though per-capita water demand could outstrip future availability in some parts of the country given population forecasts.

This supply/demand conundrum confronts not only fast-growing suburban areas in arid states like California, Colorado, and Arizona, but also places that normally receive abundant rainfall, including Georgia and Florida. “We're starting to see the limits of where people can go, especially in areas with drier weather patterns,” says an interviewee.

Other unsettling water issues include rising levels of contamination and climate change. Climate change poses long-term threats to water facilities, many of which could face flooding, and affects primary water sources like mountain snowpacks and glaciers.

While congested interstates and crowded airports inflict an economic toll from time lost in traffic and reduced productivity, a lack of water can short-circuit development and stop growth in its tracks. Simply put, we need water to survive as well as prosper. Water grows our food, remains integral to many manufacturing processes, and is essential to electric power production—even new solar technologies use steam.

There is hope, however. Interviewees contend that water availability doesn't need to turn into a crisis, if Americans start to take action now, "managing both supply and demand." Priorities include the following:

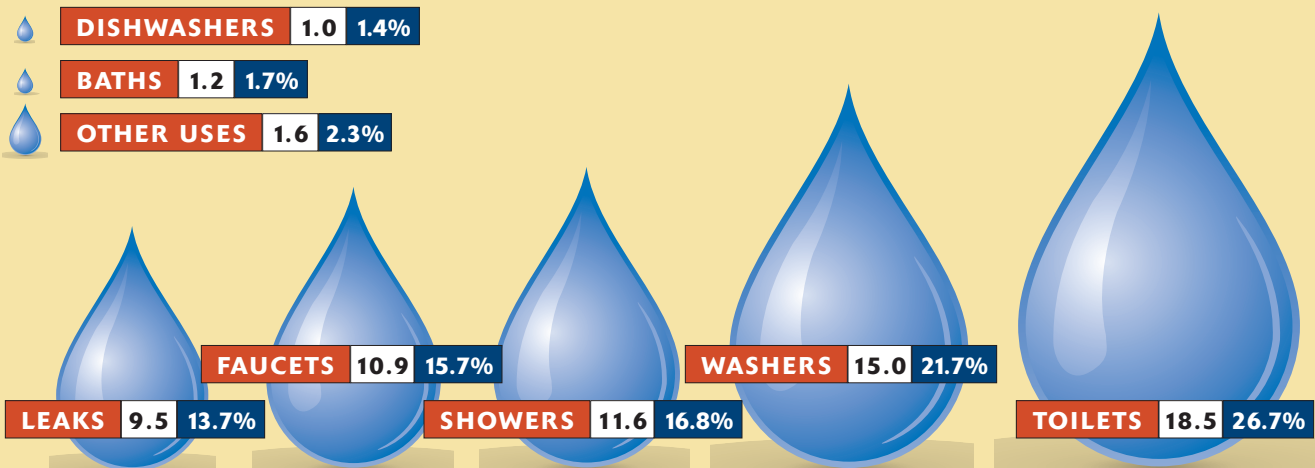
- **REPAIRING LEAKS** and modernizing aging systems;
- **DEVELOPING REGIONAL STRATEGIES** to protect supplies and plan for increasing population demand;
- **PLANTING CROPS** that require less water;
- **IMPLEMENTING** new irrigation methods;
- **USING NEW RECYCLING** technologies;
- **CAPTURING AND CONTROLLING** more groundwater;
- **LANDSCAPING** with appropriate native species;
- **ENCOURAGING CONSERVATION** and greater efficiencies; and
- **CHARGING USERS** full costs for system maintenance and capital improvements.

Make no mistake: confronting water issues will require "massive investment" and integrated regional planning with other land use concerns, including housing, transportation, power sources, and farming. Educating the public about what needs to be done doesn't fit most political mind-sets—especially when solutions involve curtailing growth, changing accepted behaviors, and raising taxes or user fees to pay for fixes. "It's the old story of people only start paying attention when there is a crisis."

FIGURE 3-1

Average Daily Water Use per Capita in the United States Is 69 Gallons. This Is How It Breaks Down:

GALLONS PER CAPITA / PERCENTAGE OF TOTAL DAILY USE



Source: American Water Works Association.

Countdown: Four Water Challenges

Americans must become more comfortable with “a new era of limits” and understand how water issues face communities almost everywhere. The water predicament stems from four basic, often overlapping scenarios:

Old Pipes at Risk

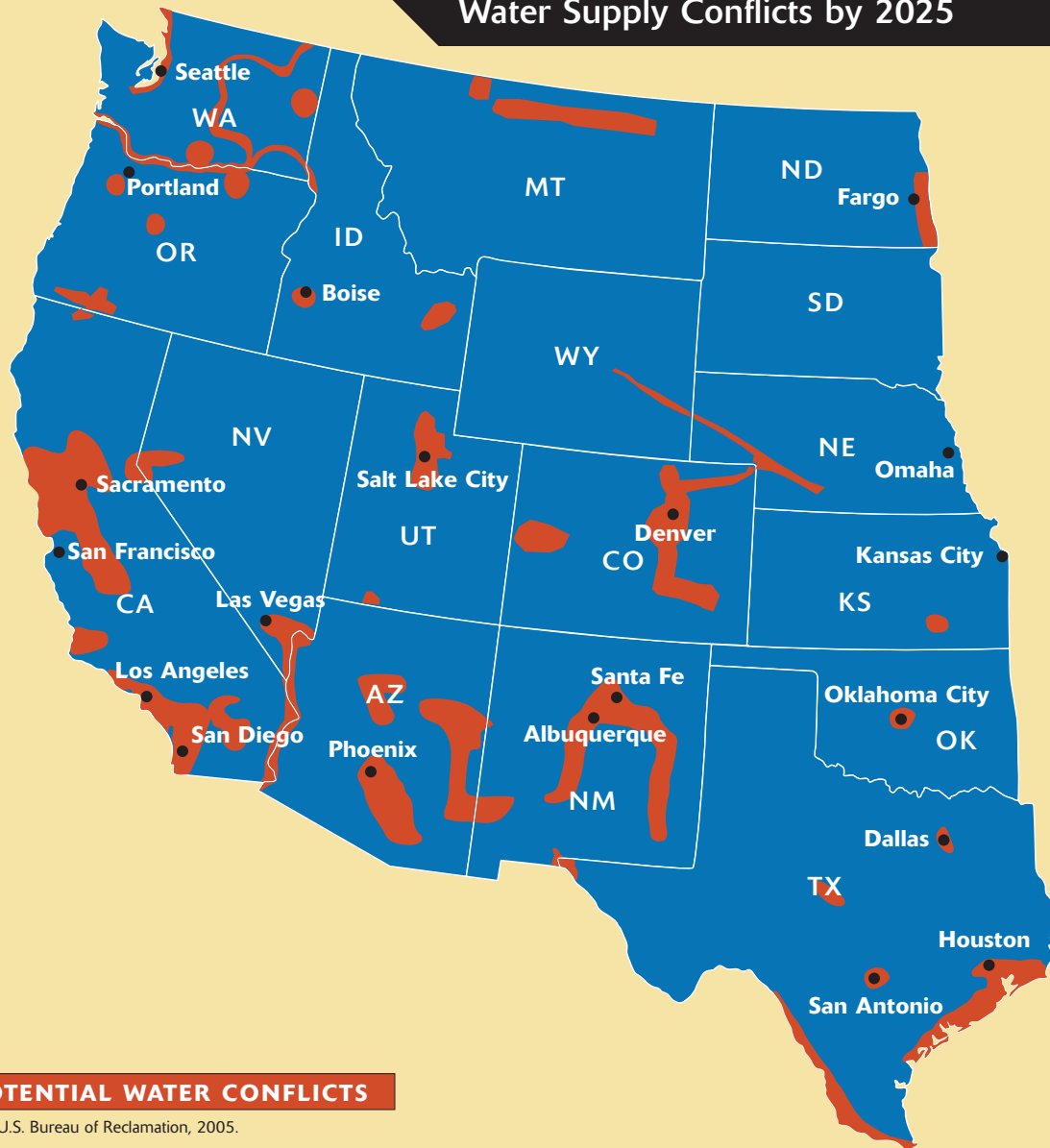
Rusting and dilapidated water infrastructure leaks away the resource and risks failure. “It’s every older city’s problem.” The United States suffers about 240,000 water main breaks annually and the country loses approximately 6 billion gallons a day—enough water to supply the entire state of California.

There are problems all across the country. A “practical goal” is for municipal systems to lose “no more than 10 percent” of their water supplies, but Buffalo, New York, leaks 40 percent and 50 million gallons escape each day from the faltering New Orleans municipal system. Officials are afraid to shut off flows through a damaged section of water tunnel leading from upstate reservoirs into New York City over fears of collapse. “It’s a ticking time bomb.”

California’s Sacramento San Joaquin River Delta aqueduct system, which supplies two-thirds of the state’s drinking water, badly needs an overhaul and could breach in an earthquake. Chicago has 4,000 miles (6,437 km) of pipe and much of the system is more than a century old, but the city “manages to replace only 70 miles [112 km] annually.” Younger urban centers like Atlanta discover that newer-vintage pipes installed 50 and 60 years ago deteriorate more quickly than cast-iron mains installed in older cities decades earlier.



The Western United States Faces Many Potential Water Supply Conflicts by 2025



Hot Growth Constrains Supplies

Many fast-growing regions, particularly in the nation's Sunbelt, likely cannot sustain current land use patterns or water use practices given projected population increases. California's system, designed to supply water to 18 million people, now struggles to serve 38 million, with an additional 12 million in population anticipated by 2040. As a result, many cities already impose rationing. In 2007, Atlanta almost ran out of water (within a month's supply) during a severe drought—what happens in a recurrence, if the city doubles in population as expected over the next generation?

In infertile zones in Arizona, Texas, Colorado, and southern California, days may be numbered for refashioning dusty scrub into suburban landscapes with expansive lawns and swimming pools. Even in Boise's high desert, homeowners plant their yards "like we get 45 inches [114 cm] of precipitation a year when we actually average 12 to 14 inches [30.5 to 35.5 cm]." The issue for western states "comes down to water informing how we grow in the future," and that means changing how and where development occurs.

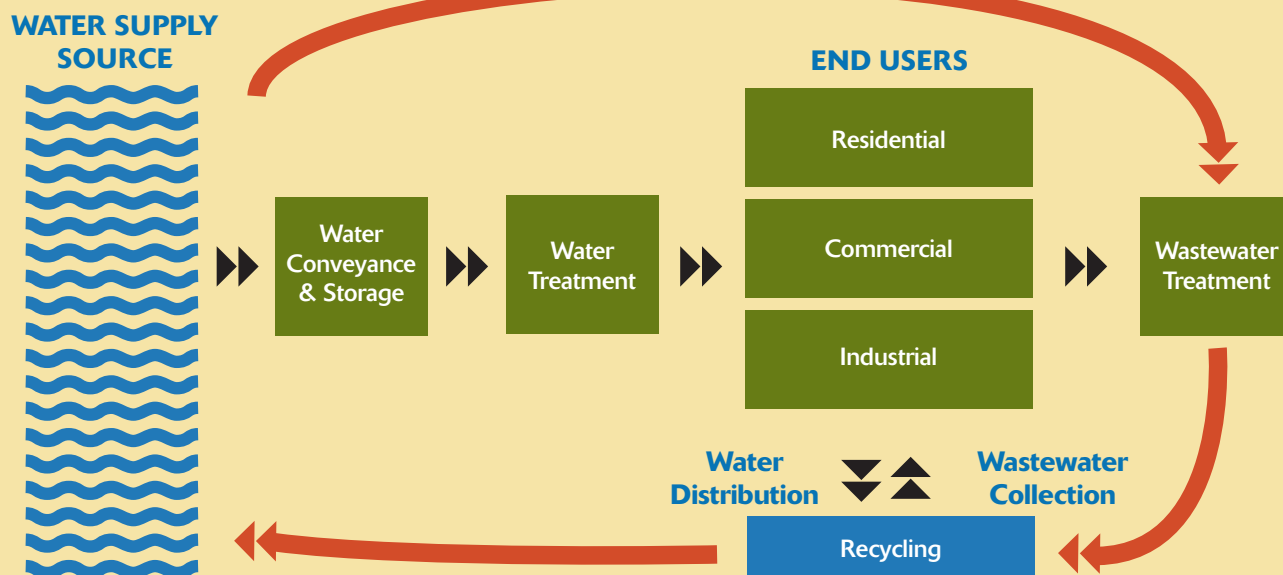
Higher-rainfall regions suffer their own water dislocations, too. After four decades of unrestrained development along its coasts, Florida copes with lowered water tables, salt water infiltration of aquifers, and encroachment on delicate replenishing ecosystems flowing into the Everglades.

Contamination Threats

Industrial chemicals and agricultural runoff permeate groundwater and settle into drinking sources—aquifers, wells, and reservoirs. "We did a great job in the 1970s hooking everyone up to wastewater and cleaning up rivers," says an interviewee, "but just scratched the surface on nonpoint pollution sources."



The Water-Wastewater Cycle: Polluted Water Supplies Create Problems Down the Line



Source: International Water Management Institute.

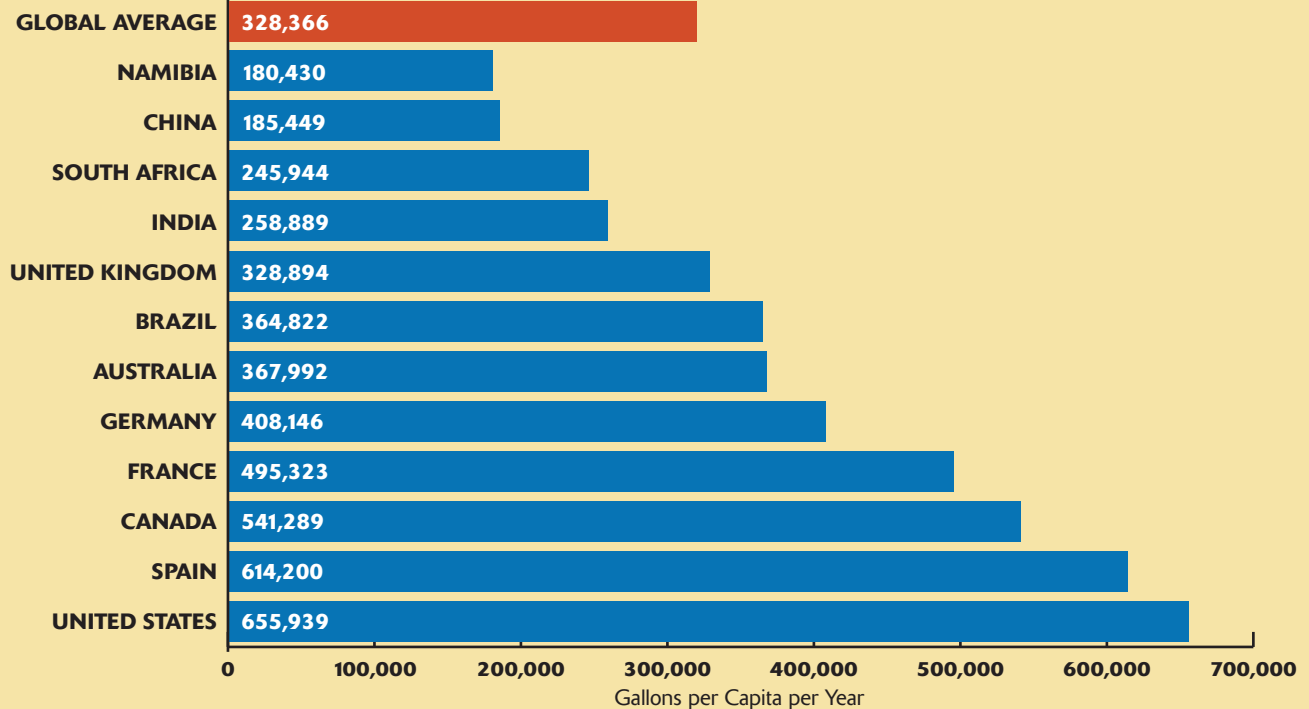
The New York Times reported in late 2009 that 62 million Americans are exposed to drinking water that does not meet government health guidelines, which to date only monitor about 100 chemicals of more than 60,000 used in the United States. Communities located near factory sites, mining areas, utility plants, farms, and even golf courses increasingly confront contamination issues from industrial sources, herbicides, pesticides, or animal waste.

Urban road runoff—rain, oil, grease, and toxic chemicals—can add to the mix of potentially dangerous ingredients ending up in water supplies. Exposure to some of these chemicals can increase chances of developing cancer and chronic illnesses, while about 9 million people in the United States annually get sick from waterborne parasites, viruses, and bacteria. In addition, traces of pharmaceuticals flushed through sewer systems now appear in tap water. Contamination problems could intensify if aging wastewater treatment facilities aren't upgraded and expanded soon to meet increasing population demand.

Sewage plants built during the early 1970s with federal Clean Water Act grants are reaching overcapacity and approaching the end of their life cycles. Already, sewage systems in many states—California, New York, Wisconsin, Illinois, and Ohio, among others—can no longer handle heavy rains, spilling human waste into local waterways. Without attention, significant gains in pollution control could be reversed, threatening water quality in many rivers, lakes, and streams.

FIGURE 3-4

U.S. Global Water Footprint Is among the World's Highest



Source: 2030 Water Resources Group, 2009.

Failure to Conserve

Put bluntly, water profligacy is an American way of life: long showers; daily lawn watering; running half-empty dishwashers or washing machines; and running the faucet while brushing teeth are a few common examples. But homeowners also fail to repair or don't recognize leaks that total 1.25 trillion gallons annually, according to the Environmental Protection Agency. This water lost from dripping taps, running toilets, and the like equals the annual water use in Los Angeles, Chicago, and Miami combined.

And compared to what is used by residents of many other countries, Americans use significantly more water per capita. The average global citizen's water footprint computes to approximately 330,000 gallons annually—about half the average American's, at close to 660,000 gallons. In China, the average citizen uses only about 185,000 gallons each year.

Total water withdrawals grew steadily between 1950 and 1980, and then began to level off, the result of decreased manufacturing, more efficient manufacturing technologies at remaining factories, and better irrigation for farming. But given population growth, which doubled since 1950 to more than 300 million, the nation's use of water more than doubled between 1950 and 2005, to more than 400 billion gallons a day; and public supply, including residential use, has risen from about 14 billion gallons a day to 44 billion, a 300 percent increase.

Climate change impacts—longer droughts, higher evaporation rates, diminished snowpacks in western states—additionally stress water supplies in many regions.

Water and Wastewater Reversals

After decades of significant progress, the United States regresses in preventing pollution from fouling its waterways. Underinvestment and a lack of maintenance leave many of the nation's 16,000 wastewater treatment plants deteriorating and ill-equipped to handle increased demand. Whatever the numbers analysis, funding gaps appear huge. The EPA estimated that nearly \$400 billion must be invested over the 2000–2019 period to update and replace existing systems and build new facilities to serve expanding populations. But the agency forecasts a 20-year funding shortfall of \$122 billion for clean water capital costs and \$102 billion for necessary drinking water projects.

The 2009 American Society of Engineers report card, which graded U.S. wastewater infrastructure at a nearly failing D-, projects a five-year funding shortfall of nearly \$110 billion. As a result of blocked or broken pipes, approximately 10 billion gallons of raw sewage are released into waterways annually. If left unaddressed, the problems can only worsen—many sewage plants built in the early 1970s have 50-year life cycles and will require replacement over the next decade.

Pollution from Utilities

Another recent threat to waterways ironically derives from efforts to stem emissions at coal-burning power plants. New chimney scrubbing systems installed under updated Clean Air

Water sits in a purification tank.



Australia: A Dry Nation Adapts

The world's driest inhabited continent,

Australia is grappling to reduce per-capita water consumption in the face of steadily increasing population in urban centers (close to 2 percent annually) and the dire consequences of apparent climate change. Caught in a severe, almost decade-long drought with no end in sight, the country has undertaken a multifaceted strategy for coping with limited water resources, involving changed habits and land use modifications. And as Australian companies have begun to market innovative water-saving technologies internationally, other regions, including parched areas in the United States, take notice out of shared necessity.

The mostly unpopulated desert landscape within Australia's vast interior outback can go years without experiencing the shadow of a storm cloud, but recently major population centers in coastal areas like Brisbane, Melbourne, Adelaide, and Perth also have struggled with diminished annual precipitation and acute water shortages. Even in relatively better resourced Sydney, the nation's largest city, complacency about water is in short supply. Simply put, reducing water use and developing new water sources have become national priorities in order to ensure the country's ability to grow and function in the 21st century. Australia bankrolls the effort through a \$26 billion (A\$30 billion) capital investment program (including \$12.6 billion [A\$14 billion] alone in 2009–2010), one of the largest outlays for any sector in the country's economy, and households pay user fees that are staggeringly high by U.S. standards.

CONSERVATION

Watching major rivers turn into unnavigable mudflats and experiencing devastating wildfires across dry suburban swaths, Australians are readily adopting water-saving lifestyles, installing dual-flush toilets (a longstanding practice) and low-flow shower heads in bathrooms. Homeowners take in stride watering bans on yards and plant drought-resistant vegetation with government subsidies to replace lawns and nonnative water-loving perennials. Cars go unwashed. Since 2003, residential water consumption has declined 20 percent across the country. In Brisbane alone, daily per-capita water use dropped from close to 90 gallons to about 40 gallons (compared to the 120-gallon average in Los Angeles).

STORMWATER CAPTURE

Planners seek to drastically reduce reliance on potable water for nonpotable purposes—historically about 95 percent of drinking

water in Australian cities has been used for nonpotable needs. Major public projects focus on collecting stormwater for toilets and landscape watering. The roof on Sydney's Olympic Stadium funnels rainwater into storage tanks used for toilets and irrigating surrounding grounds.

Builders construct storage tanks in new residential projects to supply showers and bathrooms through separate pipe systems, supplementing local water supplies. Water-sensitive urban design developed in Perth for housing and commercial developments employs integrated stormwater collection, involving bioswales, storage tanks, permeable paving, and replanting with native species. Rainwater collected off rooftops and terraces is directed to garden irrigation systems and toilets.

Water experts and engineers look to address the unresolved challenge of retrofitting housing in urban neighborhoods with graywater pipes and effective stormwater recapture systems. In one approach, local governments are distributing rain barrels and providing incentives for residents of older houses to use storage tanks to collect water directly from storm drains and gutters.

WASTEWATER RECYCLING

Installation of graywater systems in new residential and commercial projects has helped increase use of recycled water. The volume of recycled water used by industry, meanwhile, has more than doubled since 2002. In Perth, approximately 6 percent of water is recycled with an objective of increasing levels to 30 percent within 20 years. Other cities are looking at similar initiatives in attempts to reach the ambitious national target of 30 percent by 2015. On a household scale, new plumbing technologies circulate graywater from sinks and showers through treatment tanks for reuse in toilets and washing machines.

DESALINATION

Australia is taking the world lead on building seawater desalination plants in efforts to diversify its water resources, using public/private partnerships to finance and operate the projects. Six plants have been completed or are scheduled for completion before year-end 2012, serving major capital cities. The plants will have the capacity to supply 30 percent of total consumption for their regions, with expansion opportunities to increase capacity to nearly 50 percent of consumption. Projects



aim to offset large desalination carbon footprints and energy costs by operating plants off renewable wind and solar power. A recently announced \$3 billion (A\$3.5 billion) project outside Melbourne touts a 100 percent renewable energy offset from a nearby wind farm.

SHARING THE EXPERTISE

Not surprisingly, Australian entrepreneurs look to export technologies they've developed to cope with water shortages in an increasingly water-challenged world. In fact, Australian companies have become global leaders in efficient irrigation systems to reduce water use in agriculture, employing high-tech control gates, flow meters, ground probes, and recycling systems. For countries in drought-prone zones, adopting Australian methods gains momentum to keep rapidly growing populations fed. They include China, India, and Indonesia, as well as nations in the Middle East and Africa. A new trade organization for the bur-

geoning Australian water industry touts a potential trillion-dollar worldwide demand for these technologies.

UNINTENDED CONSEQUENCES

But Australia's headlong rush into water conservation, recycling, and stormwater recapture has had unintended consequences. Water flows into sewers have declined dramatically—by 25 percent to as much as 50 percent in some sewage districts—and the reduced water volumes can compromise waste treatment by overconcentrating solids in effluent-leaving plants. New roadways are being designed to direct stormwater runoff into adjacent vegetation swales to percolate into the ground, helping recharge aquifers and groundwater levels.

Concerns also lurk about the rapid rollout of desalination and whether plants can provide acceptable and dependable water quality without unintended ecological consequences from brine concentrations and chemicals used in removing salt and treating pipes.

PAYING THE PRICE

The cost for precious tap water falls squarely on Australian ratepayers—many households in urban areas are charged more than \$900 (A\$1,000) annually, rivaling electric utilities bills. In addition, water rates escalate dramatically to finance desalination schemes, increasing by as much as \$90 (A\$100) per year in Sydney and doubling in Melbourne over the next four years. To encourage conservation, higher use above certain thresholds can trigger higher kiloliter charges or outdoor watering bans. No wonder Australians have gone into water-saving mode.

Absent more rain, Australians can only hope their programs work in a crucial test watched by other countries and regions also experiencing increasing demand for diminishing water resources.

Act requirements use water to help remove air pollutants. But at some plants, like Hatfield's Ferry in southwest Pennsylvania, the resulting toxic chemical-laden discharge is dumped directly into waterways.

Utilities claim this water effluent harbors limited toxins and most dangerous chemicals like arsenic and barium are confined to solid waste, which goes into landfills lined with synthetic seals to prevent seepage into groundwater. The EPA recently imposed stricter standards on water discharges related to the scrubbing technologies, but environmentalists dispute their effectiveness in protecting drinking water.

Potential problems with utility plant landfills, meanwhile, raise separate concerns in the wake of the breach at a Tennessee Valley Authority facility in late 2008, which spilled thousands of tons of coal ash sludge into a river, causing a local environmental disaster. Officials discount fears that wells and local aquifers may be permanently polluted, but residents, who live more than ten miles (16 km) from the accident site, report noxious-smelling tap water.

Stormwater's Consequences

Urbanization and suburban development have taken a heavy toll on water resources—degrading habitat, depleting groundwater, increasing flooding, and polluting water sources. Heavy downpours can overpower sewer systems—blankets of nonporous blacktop surfaces and concrete curbs collect and funnel rainwater, often laced with a host of roadway pollutants, into storm drains and eventually rivers and streams.

Not only do overmatched sewer systems divert untreated waste into waterways, but traditional retention basins also tend to trap contaminants from roadway runoff and these concentrations of heavy metals, hydrocarbons, and lubricants can readily settle into groundwater and aquifers. Long-accepted management strategies focus on stormwater disposal rather than recapture and recycling, even in water-challenged areas.

Deficient Dams

While too little water has obvious consequences, too much water can be a powerfully destructive force—for example, New Orleans's failed levees after Hurricane Katrina. Many other communities in the United States have been developed in flood plains downstream from dams and along flood control levees, but increasing numbers of these structures may be at risk, including levees protecting high-population areas around Sacramento, California.

The country has approximately 85,000 dams, of which more than 15,000 are rated "potentially high hazard," according to the Army Corps of Engineers. High hazard means communities could flood and people die in a dam breach. Of more than 4,000 identified deficient dams in the United States or about 5 percent of the total, inspectors have determined that more than 1,800 high-hazard dams need repairs.

But the federal government and states have repaired only 80 of these at-risk structures, with significant budget hurdles standing in the way of fixing others and costs increasing with further delays. Dam repair estimates in 2009 totaled about \$50 billion, including \$16 billion for high-hazard dams—up from \$36 billion (\$10 billion for high hazard) in 2003,

according to the Association of Dam Safety Officials. Just how many dams are deficient is an open question—many more structures may be in peril and problems could easily go undetected. The Army Corps and other federal agencies oversee only about 11 percent of the nation’s dams. The remaining 70,000-plus are regulated by states, many with few inspectors and limited repair budgets.



A worker overlooks water jets in Arizona’s Glen Canyon Dam. (Tom Bean/Getty Images)

Management Meltdowns

Allocating and husbanding water creates a difficult challenge in the face of competing interests:

- **GATEWAY CITIES** and surrounding regions where the nation's population concentrates;
- **RURAL AGRICULTURE**, which needs water to grow food;
- **UTILITIES**, which require water to operate power plants; and
- **ECOSYSTEMS**, which can help sustain and replenish water sources, if protected.

"We've got to make choices over who gets what, determine a balance, and realize we can't do it all," says an interviewee. In places that don't have water, "it defies logic to pump from hundreds of miles away—we've got to work with what we've got and make the best of it."

Water Wars

Four major water ecosystems—the Colorado River, California Delta, Chattahoochee-Apalachicola rivers, and Florida Everglades—have been "badly mismanaged" in free-for-alls over increasingly precious and depleted water spoils.

- **FARMING INTERESTS** in southern California battle against Los Angeles and San Diego for Colorado River water, while Arizona, Nevada, and Colorado fight for every other drop. Farmers in central California, meanwhile, contest urban residents over the delta's supplies.
- **IN THE WEST**, cities like Las Vegas and Denver lay claim to water sources hundreds of miles away, which they pump to their residents at the expense of other communities.
- **IN THE SOUTHEAST**, Alabama utility companies, Georgia farmers, and Florida Gulf Coast fishermen skirmish with each other and against Atlanta and its suburbs over rights to the Chattahoochee-Apalachicola watershed. Georgia, in turn, seeks to gain alternative supplies at Tennessee's expense. North Carolina and South Carolina engage in separate court skirmishes over water supplies.
- **AROUND LAKE OKEECHOBEE**, sugarcane companies and local homeowners contest water use with south Florida water districts and Gulf Coast fishing interests. The Army Corps manipulates lake levels to reduce pressure on aging earthen dikes, which protect lakeside homes and agricultural land from flooding, but the Everglades ecosystem suffers.

Meanwhile, in New York, the city objects to state plans to allow gas exploration companies to pump water and chemicals into potential underground natural gas fields, a process that could compromise the city's upstate watershed.

Regional Dysfunction

Interstate and competing-use rivalries for water often layer on top of regional and local infighting. In most regions, multiple municipal and suburban water and sewage districts operate independently from each other as well as from a myriad of local planning and zoning boards. Neighboring towns may use the same water source, but charge different rates,

replicate unnecessary infrastructure systems and personnel, as well as implement different conservation policies and system maintenance plans. “We need a big shift where regions must have smart regional plans that connect the dots between zoning, water, conservation, helping every community succeed, and understanding we’re interdependent. Fixing leaks in the city can help the suburb next door.”

The Land/Water Disconnect

Until recently, water planning—the province of state governments—didn’t figure prominently into land use policies, which are governed primarily at the local level. In the eastern U.S., states adopted riparian rights rules for water based on shared use of waterways by owners of adjacent lands. In the drier West, states enacted various versions of “first-come, first-served” prior appropriation doctrines, separating land ownership from water rights, which were bought and sold by whomever staked original claims to the water.

An aqueduct carries water through California’s San Joaquin Valley.



As long as water could be taken for granted, local governments concentrated on attracting more residents and businesses to increase the tax base, and state officials were loath to interfere. This land/water disconnect never served to encourage any regional planning for sound water management. Now, some states are tentatively forcing local jurisdictions into more concerted water planning modes out of necessity:

- **ARIZONA REQUIRES “ASSURED WATER SUPPLY” EVALUATIONS** in the state’s large urban areas, but exempts less developed regions where future water availability might be even more questionable.
- **FLORIDA MANDATES** that municipalities where water availability is in doubt adopt ten-year plans for identifying sources of water and maintaining water infrastructure, including capital projects.
- **CALIFORNIA FORCES VERIFICATION** of water availability for all subdivisions of 500 or more units, but developers can sidestep requirements by building smaller projects.
- **NEW JERSEY REQUIRES DEVELOPMENT APPROVALS** conditioned on water adequacy, but leaves wiggle room by not defining adequacy clearly.

Logically, “appropriate water use” should be integral to local planning and zoning, and the paradigm begins to shift, particularly in many hot-growth areas. Planners, prodded by state regulations and the realities of recent droughts, start to address how to ensure future water availability. They pay attention to studies that show how subdivision development on big lots—the suburban homebuilder’s method of choice for decades—exacerbates storm-water runoff, can degrade water quality, and destroy local environments. These studies indicate that concentrating more homes on single lots in cluster projects protects watersheds better—runoff rates are lower for higher-density projects.

Changing the land use palette and landscaping with native plants also can cut water use significantly—“30 percent or more.” Once the economy resuscitates and homebuilding resumes, expect “more townhomes and smaller lot sizes with smaller homes—there’s a general pattern of conservation and efficiency coming.”

Forward-thinking communities in arid regions begin requiring developments to incorporate recycling and rainwater capture systems, which can be used for landscape irrigation. The city of Santa Fe, New Mexico, creates a water bank, trading water offsets for entitlements, and requires developers to install new efficiency toilets in existing homes before obtaining new development permits. Las Vegas residents can claim monetary rewards for converting lawns and flower gardens into less water-needy yards.

Limited Federal Engagement

Avoiding entanglements in states’ rights issues and local property rights prerogatives, the federal government has “dropped the ball” on encouraging interstate or regional planning for water resources. Various agencies—the U.S. Environmental Protection Agency, the Army Corps of Engineers, and the departments of Energy, Agriculture, and Energy—don’t collaborate or coordinate on any overarching policies that tie together water quality, resource management, and system upgrading—and “no real funding exists for new technologies.” In this siloed bureaucracy, “everything is done separately without productive outcomes.”

“They create perverse incentives by perpetuating old-school funding formulas from the Clean Water Act days based on providing grants for one-off water quality projects,” says an interviewee. “An exurban residential project can get funding to clean up radon-contaminated well water to allow new development, but an infill suburb can’t get funding for innovative approaches that modernize systems and encourage conservation.”

Many state officials look to protect their turf when they argue against interference from Washington—“a federal water management plan would be crazy.” But they often agree that more federal involvement could help mediate and resolve regional disputes over interstate watersheds, which often result in drawn-out litigation.

The Water/Energy Nexus

Water use and energy production are inextricably tied together, but energy and water utilities generally don’t collaborate on long-range planning, and government policy has not facilitated the process. The U.S. Geological Survey estimates that over half of the water consumed in the United States is eaten up by electricity generation, and water systems need vast amounts of energy to treat and distribute water.

Electric companies either consume vast amounts of water in generating steam to push turbines or rely on hydropower from dams. Even low-emissions solar power technologies depend on water to operate. According to the U.S. Department of Energy, coal-fired plants use 110 to 300 gallons of water per megawatt hour; nuclear plants use between 500 and 1,100 gallons; and solar parabolic trough plants use 760 to 920 gallons. Except for wind power and solar photovoltaic cell, “you cannot produce energy without water.” Water also is vital for coal mining and in land-based oil and gas exploration.

In turn, water utilities have prodigious energy appetites. In California, “20 percent to 25 percent of the state’s electricity” powers pumps, pushing drinking water into metropolitan areas from increasingly distant locations. Similarly in Arizona, a 336-mile (540-km) canal and 15 pumping stations convey Colorado River water uphill to Phoenix and Tucson, a process that requires half of the electricity of a power plant. Sewage treatment plants are also “highly energy intensive.” “It’s a vicious cycle—you need water to produce energy, but to get good water you need energy, so you need more water to provide more water.”

Technical advances in finding new water and energy sources complicate the interdependence. Mirror-reflecting solar power plants may address carbon footprint issues, but they are best located in sun-drenched, barren desert environs that don’t have much water. In order to run these plants, states must channel water away from residents and farmers.

Desalinization plants, long touted as a possible alternative for producing drinking water from the oceans, have the opposite problem—their salt extrusion technologies depend on huge amounts of electricity to operate and can result in large carbon emissions.



Thirsty Agriculture

Rice—a water-intensive crop—grows in California's Sacramento Valley. (Dr. Marli Miller/Getty Images)

No one begrudges American agriculture from using more water than other sectors—the U.S. farm industry produces more food than any other country in the world. Excluding thermoelectric, farmers use about 60 percent of America's freshwater withdrawals, but have steadily reduced their requirements from a peak of 150 million gallons per day in 1985 to below 130 million in 2005. Farms—especially in California and western states—start to employ more sophisticated irrigation technologies and use more groundwater. Sprinkler irrigation techniques allow more targeted and precise application of water, and new micro-irrigation approaches developed in Australia offer options to cut water use further.

Interviewees nevertheless suggest that agriculture needs to adopt water-saving techniques more widely. In thirsty California, where 80 percent of all water goes to agriculture, farmers eventually may be forced to curtail cultivation of high-water-intensity crops like alfalfa, rice, and cotton. Federal water subsidies to agriculture haven't helped—farms “pay almost nothing” for water, so they have no incentives to conserve. “In the battle over water between farmers and cities, the cities have the votes and farmers will ultimately lose.”

Urban-versus-agriculture fights over water are bound to increase beyond parched sections of the country. Southeast and Midwest farmers have been slower to adopt efficient irrigation methods, while pesticides, herbicides, and animal waste contaminate important water sources for many population centers.

Water Solutions

The new water management model will require innovation, holistic approaches, conservation, and regional collaboration, taking into account land use strategies and energy demands. Wastewater and stormwater schemes will become integral to sustaining water supplies, utilizing improved landscape designs, recycling systems, and irrigation technologies. Everyone must prepare to pay more and use water more efficiently to ensure availability. Below is a road map for getting on the right track:

Get Governments' Act Together

Although states and local governments resist federal interference, they crave Congressional allocations. Federal monies should be conditioned on states' drawing up long-range regional water management programs that integrate water supply and conservation strategies with population projections, agricultural needs, and utility demand.

States should receive more funding for developing schemes with local governments that create efficiencies and ensure water availability as well as water quality, incorporating wastewater and stormwater solutions. At the local level, myriad water and sewer districts need incentives to consolidate and/or work together with zoning and planning agencies to develop programs that meet regional objectives and guidelines. "You can't tap dollars without a plan for doing more with less."

Embrace Collaboration

This process requires broad collaboration among agencies, regions, and communities—"thinking and planning strategically" across bureaucracies to achieve "holistic solutions." "That's what's happening in California out of necessity." You need "to get everybody working together." Management has been too local and parochial. "We need to share water resources on a bigger scale."

Face Reality

Dealing with water-related infrastructure problems means ratepayers and taxpayers will pay more to ensure reliable and safe supplies. Part of addressing solutions means government leaders need to educate the public about the realities and phase in higher rate structures to start funding necessary improvements as soon as possible.

Fix It First

Priority must be given to repairing leaks and upgrading existing systems, particularly aging sewage plants. Regions must either pay now to prevent future breakdowns or pay more when the breakdowns inevitably occur.

FIGURE 3-5

Higher-Density Development Produces Less Runoff Than Lower-Density Development per Unit

Scenario	Number of Acres Developed	Total Runoff (foot ³ /year)	Runoff per Unit (foot ³ /year)	Savings over One House/Acre: Runoff per Unit (%)
One house/acre	1	18,700	18,700	0
Four houses/acre	1	24,800	6,200	67
Eight houses/acre	1	39,600	4,950	74

Source: U.S. Environmental Protection Agency, 2006.

Integrate Land Use into Water Management

For starters, development needs to be restricted in areas without ample future water resources. Especially in arid zones, developers need to incorporate water recapture (cisterns) and recycling (graywater) systems for irrigation into plans and designs. Landscaping should use native species and avoid water-intensive plantings—this vegetation also requires less use of groundwater-polluting herbicides and pesticides.

Dense development concepts reduce stormwater runoff and enable greater groundwater retention and recharge—town center schemes not only work from a convenience, reduced car-dependence standpoint, they also can use water more efficiently. Communities should look to limit impervious pavement and use various low-impact development strategies, including preserving more open space and landscaping with rain gardens, bioswales, and flow-through tree boxes/planters. Road systems and parking facilities should incorporate similar low-impact concepts.

Protect Ecosystems

An essential part of proper land use and water management lets natural flood plains and watersheds husband water and restore sources. “Nature builds for free if we leave well enough alone.” California will spend billions of dollars to reclaim ecosystems lost in damming and development around the California Delta. Florida may need to do the same to preserve the Everglades.

Think Comprehensively

Moving beyond dependence on pulling water out of rivers, lakes, and aquifers means collecting and using all available water resources—capturing rainwater off roofs and pavement, recycling wastewater, recharging groundwater, and making nonpotable water potable. “You need to figure out creative ways to stretch what’s all around you and use what you have more effectively.” At times of heavy rains, conjunctive use concepts collect surface water in storage holes and recharge aquifers for later use in dry periods. Wastewater can be separated into graywater and sewage, treated or purified, and reused for irrigation, thermoelectric, and industrial operations to reduce demand on drinking water sources.

Reduce Agricultural Demand

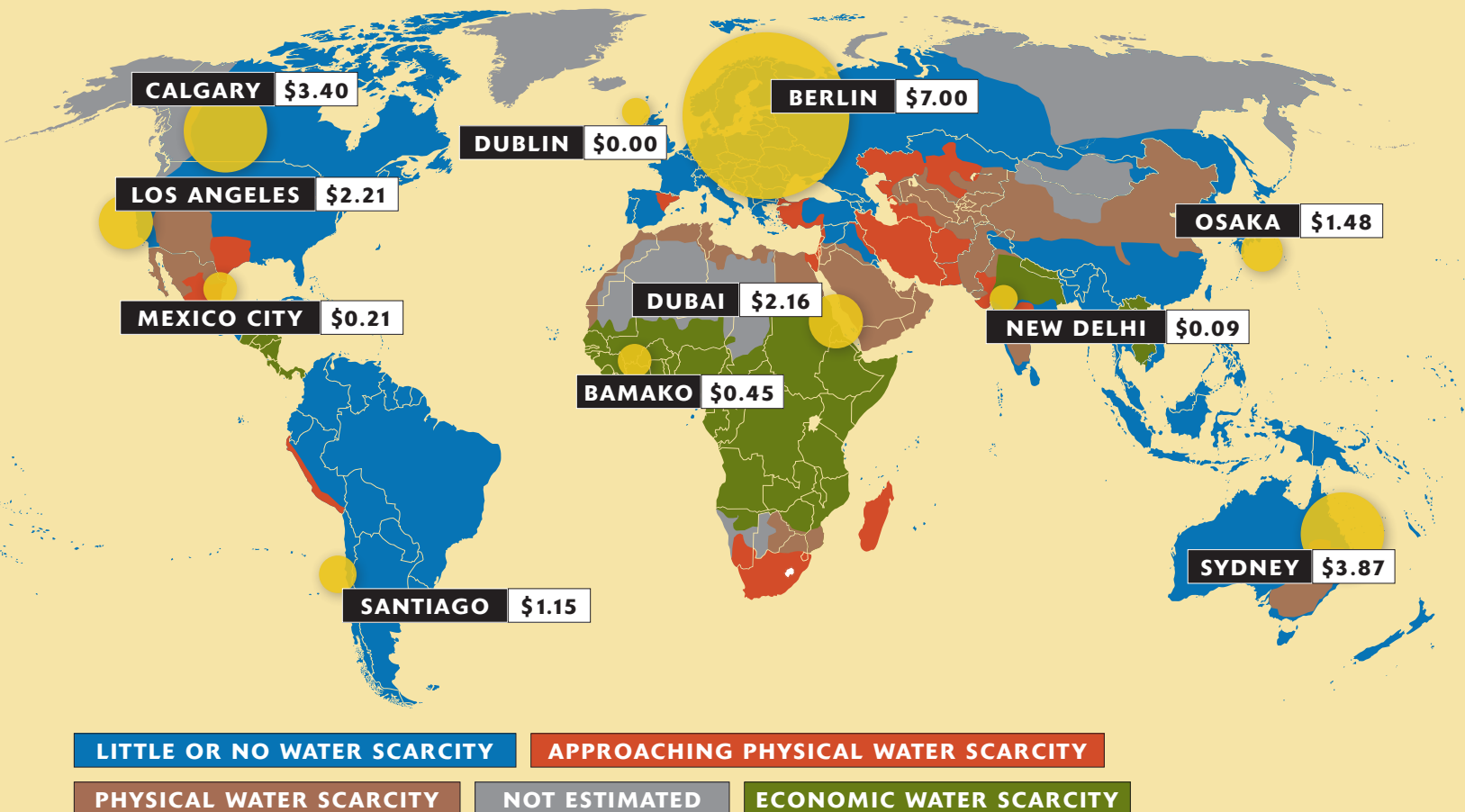
The federal government incentivizes farmers through myriad price supports and subsidies to grow certain crops and take others out of production. Especially in water-challenged areas like California, farmers need incentives to reduce water use either by not cultivating water-intensive crops or adopting more sophisticated irrigation techniques, which limit water use. That means shifting away from certain crops and providing incentives to purchase high-tech sprinklers and ground sensors and/or build more efficient irrigation systems.

Moderate Household Consumption

Experts suggest that Americans could reduce water consumption by 35 percent without noticeable changes to lifestyles. Installing double-flush toilets and air-injected showerheads, fixing leaks, and using washing machines and dishwashers more efficiently would help conservation efforts. Watering lawns less frequently and conserving electricity (remember, power uses a lot of water) would help, too. In arid regions, relandscaping yards with drought-resistant turf can be a huge water saver.

FIGURE 3-6

Globally, Water Tariffs Bear Little Relationship to Water Scarcity



Note: Costs noted are price per cubic meter.
 Source: International Water Management Institute.

Encourage Conservation and Raise Rates

People need economic motivation to conserve more. “Current water markets don’t function properly” and conservation isn’t top of mind, because “a supply/demand curve doesn’t exist and no one knows the true costs.” Water is relatively cheap, users can’t easily relate how much they use to how much they pay, and a link doesn’t exist to the costs of infrastructure maintenance and capital improvements. Higher rates would get people’s attention about conservation as well as help fund necessary repairs and upgrades.

Smart water meters could help households and businesses track water consumption and costs against various habits, and help change behaviors accordingly to reduce bills. Rates could adjust to water availability and time of day—discouraging garden watering during hot afternoons when evaporation intensifies. A “Water Star” program for appliances, similar to the federal Energy Star program, could help educate consumers and businesses about making better choices for purchasing water-saving devices and systems.

What about Desalinization?

Australia, Israel, the United Arab Emirates, and Spain are turning to desalinization for overcoming water shortages out of sheer necessity, but forays in the United States have been disappointments. The plants can be costly billion-dollar-sized projects. They are extremely energy intensive, creating large carbon footprints, and indirectly use water to create water as a result of traditional utility generation processes. The high salt and chemical content of desalinization effluent can deleteriously affect sea life. “A big problem is what to do with the leftover brine.” Desalinization proponents hope that technology improvements can overcome some of the pitfalls.

Desalinization plants in the Canary Islands consume lots of power to produce potable water.



Water in Selected Metropolitan Regions

No major metropolitan region

in the United States can claim insulation from water-related problems and costs. Budget-busting system breakdowns may slam older cities in the Northeast and the Midwest, while western urban centers deal with how to protect threatened supplies and meet demands from growing populations. In the Southeast, rapid development and poor management compromise resources as states, counties, agricultural interests, and power companies wrestle over available supplies. In most places, wastewater treatment plants are either too old or reach capacities for treating increasing volumes of effluent from expanding populations. Contamination from stormwater runoff and related non-point source pollution also becomes a major issue just about everywhere.

In fall 2009, ULI/E&Y conducted an extensive survey of 14 major metropolitan regions. Research included interviews and meetings with leaders and water managers, in-depth review of regional water data, and a survey of water-related news. The following information highlights issues facing water systems in 14 major metropolitan areas:

ATLANTA, GEORGIA

Consider these facts:

- The greater Atlanta region almost ran out of water during a 2007 drought.
- The area's water requirements are forecast to double by 2030 as the population swells to 8 million.
- After a 20-year interstate legal battle, the U.S. Supreme Court ruled that Atlanta no longer has an exclusive right to its primary water source, Lake Lanier, and must share supplies deemed essential to the Chattahoochee-Apalachicola watershed with Alabama and Florida. To make up for the lost supply, the metropolitan water district will need to build six new reservoirs, estimated to cost about \$400 million.
- Surrounding counties are now clashing with Atlanta over control of various water sources, while the disparate jurisdictions lack any unified plan for managing growth or water needs.
- The metropolitan water district budgets an additional \$4 billion to remediate sewer overflow and increase capacity for overwhelmed sewer systems—after heavy rains, stormwater runoff can raise bacteria counts to unsafe levels in reservoirs.

FIGURE 3-7

Water Challenges and Programs in Selected Metropolitan Regions

Metropolitan Region	Aging Pipes	Uncertain Water Supply	Struggle with Regional Coordination	Conservation Programs
Atlanta	✓	✓	✓	
Boston	✓			✓
Chicago	✓		✓	✓
Denver		✓	✓	✓
Houston		✓		✓
Los Angeles	✓	✓	✓	✓
Miami-Dade	✓	✓	✓	✓
Minneapolis/St. Paul	✓		✓	
New York	✓			✓
Philadelphia	✓			
Phoenix		✓	✓	✓
San Francisco	✓	✓	✓	✓
Seattle		✓	✓	✓
Washington, D.C.	✓			✓

Source: Urban Land Institute analysis based on interviews and data reviews.



Following four decades of rapid growth and sprawling development, reality is forcing Atlanta into scrambling to address water problems years in the making. The jurisdictional infighting only complicates the process. Water rates and taxes have nowhere to go but up to pay for new systems and upgrades. Expect conservation and water recycling systems to become a big part of residents' futures, too. In a region with a laissez-faire planning culture, the state is attempting to set boundaries for newly established regional councils to develop water plans and manage resources. In the meantime, everybody prays for rain.

BOSTON, MASSACHUSETTS

Massachusetts benefits from abundant rainfall of about 45 inches (114 cm) a year, but the eastern part of the commonwealth around metropolitan Boston is suffering increasing withdrawal rates from reservoirs and aquifers as well as degraded watersheds.

While reservoirs in western suburbs provide ample water to the city, many surrounding suburban water districts exceed withdrawal limits from various river and groundwater sources. Local rivers experience both extreme low flows during the summer at high water use times and extreme high flows in cooler months. The culprit in both cases is water runoff from impervious surfaces—the result of suburban expansion in watershed areas. In warm weather, aquifers don't get recharged quickly enough—paved areas don't absorb rain and storm drains instead shunt precipitation directly into rivers and streams. When rivers aren't low, the runoff can damage banks, while in both scenarios contaminants flush into watersheds. The river extremes play havoc with aquatic habitats and compromise watershed integrity, threatening future water supplies as suburban populations continue to grow.

Boston's original water and sewer systems date from wooden pipe days in the 1600s—the city faces the ongoing and expen-

sive challenge to replace water infrastructure, much of which is over 100 years old. Plagued for years by substandard wastewater treatment facilities, the city has overcome the legacy of sewage dumping into Boston Harbor, but copes with the high cost of funding plant upgrades and new disinfection technologies.

CHICAGO, ILLINOIS

Too much water can be a bit of a curse. Possibly lulled into complacency by its abundant Lake Michigan supply, Chicago and its suburbs face a host of water-related issues, including a disconnect between water rates and infrastructure costs. Officials have been slow to address needed system upgrades and storm-water runoff issues.

Like other Great Lakes cities, Chicago's use of lake water is governed by the Great Lakes Compact, which generally mandates that the city return what the city takes out. But residents who gaze out at the vast lakefront not surprisingly aren't great conservers—more than 350,000 homes in the city don't even have water meters. "Chicago may not experience water shortages, but people waste an immense amount."

Like other older cities, Chicago's massive underground network of pipes and mains has outlived its age of reliability, but the city replaces only a small fraction of the system annually—deterred by huge costs, empty government coffers, and a reluctance to increase rates for such an apparently plentiful resource. Interviewees suggest metering and water main replacement would save enough water to provide for 700,000 additional people, and help raise funds to replace aging systems.

The city, meanwhile, delivers water to inner-ring suburbs, charging the same rates applied to city customers, despite extra



pumping costs. Inland suburbs, representing about 15 percent of regional water users, rely on aquifers, but population growth and recent withdrawals outstrip natural groundwater replenishment, and contamination from radium and other pollutants begins to raise red flags. While possible and even desirable, extending lake water delivery infrastructure to these suburban areas would be extremely costly. “The entire region desperately needs a comprehensive water management plan to resolve inefficient use of resources collaboratively.”

Chicago also doesn’t effectively capture and recycle stormwater runoff, which, if it doesn’t overflow sewers, gets treated at ratepayers’ expense and released into a sanitary canal flowing toward the Mississippi River, not back into the lake.

To the north, Milwaukee constructed a deep tunnel system to prevent sewage overflows and collect stormwater—“every drop used from the lake is treated and returned.” This strategy minimizes polluted stormwater runoff, while helping meet requirements for restoring lake water under the aforementioned compact. Milwaukee hopes to take advantage of its efficient water management system, using lower water rates to lure new industry into the city.

DENVER, COLORADO

Old can be good when it comes to water systems in Colorado and other western states, and Denver boasts one of the oldest systems in the region. That means the city has first-in-line rights to supplies in watersheds it secured many decades ago outside city borders and in some cases hundreds of miles away. Towns adjacent to Denver reservoirs may have no rights to the water at all under prior appropriation doctrines. When water shortages strike, some

communities may be unable to ensure sufficient supplies.

A harsh drought in 2002 and climate change scares serve as “wake-up calls” to plan for future shortfalls. Denver expands some high mountain reservoirs and looks to secure additional sources, especially in light of increasing population. “But there’s no shortage yet.”

While many western states adopt water plans, Colorado divides into local water basins managed by roundtables composed of water district officials, environmental advocates, business leaders, agriculture interests, and state agency representatives. “We’re trying to build a statewide consensus on what to do.” No doubt, water availability will increasingly play a role in land use planning and development, and “water needs to inform how we grow.” Local builders start to adapt wastewater recycling and stormwater capture schemes into developments.

HOUSTON, TEXAS

Houston has enough water from a group of surrounding lakes, rivers, and aquifers to sustain its continuing rapid population growth track expected in the next 25 years, according to its Department of Public Works. The city looks to access more water from the Trinity River and reduce dependence on groundwater sources by embarking on the Luce Bayou Project, which will transfer water from the Trinity River to Lake Houston and the San Jacinto River for distribution and consumption. Over the years, withdrawals from aquifers have resulted in land sinking in some districts.

In general, the expansive city’s 7,000 miles (11,265 km) of mains and pipes don’t require near-term replacement—about 70 percent are 40 years old or less. The city’s primary sewage treatment plants, built during the 1980s, won’t need near-term overhauls either, although population gains will necessitate new wastewater facilities.

Problems from nonpoint source pollution and stormwater runoff pose the greatest ongoing challenges for the region. The city averages 50 inches (127 cm) of rainfall annually and frequent summer thunderstorms can cause flash floods across extensive suburban expanses.

Local petro and chemical plant discharges can find their way into groundwater, and agricultural runoff inevitably flows into rivers that feed local lakes and reservoirs. “Around Houston, just about every body of water is contaminated.” In fact, a 2009 study by the Environmental Working Group rated Houston’s water quality 95th of 100 major U.S. metro areas.



LOS ANGELES, CALIFORNIA

In Los Angeles, acute drought conditions force residents into extreme conservation mode—total consumption during 2009 dropped almost 20 percent to early 1990s levels, when the city had many fewer residents. Through rate structures, the water district is incentivizing lowered use and punishing large consumers with higher charges—rates in some parts of southern California have increased by upwards of 40 percent in the last three years.

Locals can only hope that weather patterns change in the Rocky Mountains and Sierra Nevada range, the source of most of southern California's water. But fears grow that diminishing mountain snowpacks and higher evaporation rates result from permanent climate change, which could impair essential supplies from the Colorado River and California Delta.

City officials insist that agriculture users in California's Central Valley give up subsidized allocations allowed under federal contracts executed before California's urban populations mushroomed. "They get four times more water than the metropolitan areas and pay almost nothing for it, so you don't see much efficiency." Some farmers in turn take fields out of production and offer to sell their water rights to cities. State leaders gain traction on plans for an \$11 billion bond issue to restore damaged delta ecosystems, capture and retain more mountain water flows, increase groundwater levels, and upgrade deteriorating water infrastructure.

In the meantime, residents may need to conserve more. Even with cutbacks, the average L.A. household uses close to 150 gallons a day, more than three times the consumption rate in Brisbane, Australia, where coping with drought has become a way of life. Orange County operates a new wastewater recycling plant that injects treated sewage water into the ground to seep back into aquifers and form a protective barrier against saltwater intrusion. The plant produces up to 70 million gallons a day and the purification process requires half the energy necessary for pumping water from northern California.

MIAMI, FLORIDA

South Florida may garner one of the highest annual rainfall averages in the United States, but limited storage capacity leaves the region vulnerable in droughts, and water restrictions are common during drier winter months. Rising demand from decades of double-digit population growth stresses aquifers that



supply most drinking water in the region, but many residents chafe over lawn watering limits and new water rate schemes that raise monthly bills for big consumers.

The state's environmental protection agency is augmenting a comprehensive program to promote more efficient water systems in homes, and water districts are beginning to build new recycling infrastructure to help recharge depleting aquifers. Recycled water also will be used to irrigate golf courses and other large landscapes as well as to rehydrate damaged wetlands.

The region continues to live with the unintended consequences of damming Lake Okeechobee in the 1930s to control flooding, promote sugarcane growing, and enable development. Water diversion has damaged the Everglades and related river ecosystems, while slowing replenishment of essential underground reservoirs. Political infighting between agricultural interests, landowners, environmentalists, and water districts on both coasts stymie attempts to make fixes.

MINNEAPOLIS/ST. PAUL, MINNESOTA

Water availability has not been an issue in the Twin Cities, except briefly during a late-1980s drought, but contamination and pollution can raise concerns. Minneapolis takes all its water out of the Mississippi River and St. Paul supplements river water with sources from deep wells. Locals, meanwhile, consume at rates well below the national average.

But the Big Muddy could be cleaner—farm runoff and industrial pollution contaminate the river to below drinking standards. Water supplies are being cleansed through sand filtration systems and a new \$60 million ultra-filtration plant to ensure what comes out of taps meets federal water quality requirements. The Metropolitan Planning Council is addressing the need to upgrade wastewater treatment with a ten-year, \$1.4 billion initiative

and programs to encourage higher-density development—attention focuses on controlling stormwater and limiting impacts from nonpoint source pollution.

In the outer suburbs, naturally occurring radium and agricultural contaminants seep into wells and aquifers, requiring careful monitoring.

NEW YORK, NEW YORK

New Yorkers use about 1.1 billion gallons daily, down from as much as 1.6 billion gallons in the mid-1980s. With storage capacity at 580 billion gallons, water supply is not the issue—the city’s three sprawling upstate watersheds can provide plenty as long as the infrastructure holds up. But that’s a potential problem. The system’s largest aqueduct leaks up to 36 million gallons daily. While officials say the tunnel is stable, necessary repair work would force its extended shutdown and draining—stressing remaining reservoir supplies and requiring extensive conservation measures. The city has been building a new 60-mile (96.5-km) backup tunnel since 1970, but only two of four phases have been completed, and the cost has jumped from \$1.5 billion to \$6 billion.

Like those in other older U.S. cities, New York’s water mains and pipes live on borrowed time, although some original cast-iron and brass fittings outlast more recent alloy and plastic replacements. Frequent water main breaks are bound to become more common.

Additional threats involve pollution runoff into watersheds from farms and suburbanizing areas. The city continues to buy land surrounding its reservoir system to create a wider protective buffer and will open the world’s largest ultraviolet disinfection facility in 2012 to destroy pathogen inflows from its two biggest watersheds.

Stormwater runoff into an aging sewage system (one of the nation’s first—started in 1849) presents more problematic challenges—overflows are common in this paved-over metropolis, with resulting untreated sewage spills directly into surrounding rivers and bays. City officials estimate they need nearly \$60 billion to prevent all overflows, but the federal stimulus bill allocated just \$15 billion to improve sewers and water systems nationwide. Not surprisingly, annual water and sewage rate hikes have been climbing into the double digits. “We need to pay for huge needs.”

PHILADELPHIA, PENNSYLVANIA

Talk about older cities with old water infrastructure! Some Philadelphia water mains date back to 1824. No wonder the city is undertaking a leak detection program. Population declines and the loss of manufacturing plants have resulted in lowering consumption trends, and the city has not engaged pricing strategies to encourage conservation.

But the city’s water department has developed a program to reduce stormwater runoff and sewage system overflows by implementing comprehensive green strategies and new groundwater recycling systems. Green strategies include curbside tree trenches, green roofs, stormwater planters, rain barrels, rain gardens, pervious paving, and converting underutilized paved properties into park space.

Contamination issues raise the biggest concerns for local water officials—the Schuylkill River, the city’s primary water source, flows through heavily populated suburbs and nearby industrial areas, and had been called one of the nation’s dirtiest rivers before its cleanup in the 1940s and 1950s.

PHOENIX, ARIZONA

Phoenix puts on a brave face regarding its future water supplies, while dealing with how to accommodate fast-track population growth in the middle of a desert. Most of the city’s tap water originates from mountain snowpacks in the southern Rockies, but projections suggest a 50-50 chance that Lake Mead, one of the city’s primary water sources, could run dry during the next half century because of climate change and frequent droughts.





Local residents and businesses confront the imperative to reduce per-capita water use, now among the highest in the nation. Since about two-thirds of consumption stems from outdoor applications, conservation strategies will involve replacing lawns and flower gardens with cactus and other native landscaping as well as cutting back on swimming pools. The city is among the leaders in employing graywater recycling (about 90 percent of wastewater is reclaimed) for nondrinking uses, including irrigating golf courses, which undergird its large resort industry. Reclaimed water also gets allocated for power plant cooling, habitat restoration, groundwater recharging, and farming.

Over the long term, Arizona must make hard decisions about apportioning water to agriculture. Sustained residential growth may be difficult or impossible without sacrificing farm interests. At least the recession and housing bust relieve some pressure—for now.

SAN FRANCISCO, CALIFORNIA

Residents in San Francisco use less water on average than any other major metropolitan area in the country—the city’s dense urban environs confine most consumption indoors. In contrast, water use averages are much higher in other parts of California, where landscaping can account for 60 percent of consumption. Locals also conserve aggressively, having reduced per-capita water use by one-third over the past three decades. That’s good, since California is in the midst of a four-year drought and state officials promise the smallest allocation to water districts supplied from the State Water Project system since 1967—only 5 percent of total volumes requested.

Diminished snowpacks in the Sierra Nevada Mountains, an apparent result of climate change, mean less summer runoff, requiring greater husbanding of rainwater and increased implementation of recycling strategies. “The state will need to build more reservoirs.” But the region’s biggest concern focuses on the Sacramento–San Joaquin River Delta, which supplies about 30 percent of the Bay Area’s water as well as other population centers throughout the state.

A major earthquake could destroy fragile levees, causing salt-water infiltration and contaminating water sources. Fixing the levees and upgrading related infrastructure could cost billions.

A separate aqueduct system servicing the city runs over three earthquake faults and requires \$4.3 billion in buttressing and repairs.

SEATTLE, WASHINGTON

Despite its rainy reputation, Seattle has experienced three severe summer droughts in the past quarter century—in 1987, 1992, and 2005—and local officials have been leaders in implementing effective water management programs. The combined impacts of higher water rates, conservation policies, and new plumbing codes keep total consumption below 1992 levels even as population increases, and resource managers express confidence about sufficient water supplies through 2060. Programs with targets to save 11 million gallons daily encourage installation of efficient water systems and equipment including toilets, showerheads, and washing machines, as well as using rain barrels to collect water during high-precipitation winter months for use in landscaping during typically dry summers. The rain barrel program also helps control stormwater runoff.

WASHINGTON, D.C.

Hobbled by chronic underfunding and one of the country's oldest water delivery/sewer systems (mostly built more than a century ago), the nation's capital confronts the risks of aging infrastructure with crossed fingers and attempts at innovative solutions.

The big problem is a familiar one—lack of money. “Underfunding of system maintenance is a rate structure nightmare” and addressing problems will cost billions over the next few decades. While implementing a \$3.2 billion, ten-year capital improvement project, the D.C. Water and Sewer Authority defers maintenance on some badly rusting water mains and pipes. The agency received \$58 million from the federal government in the stimulus package, but it’s “not enough to get us where we need to be.” One newly enacted revenue source is a local tax on plastic grocery bags.

The District also has trouble accommodating growth in emerging neighborhoods outside of downtown. Developers gripe about the lack of capital improvements in water infrastructure

necessary to host new projects, and officials discuss aggressive financing and taxing options to make necessary upgrades and repairs, “but nobody wants to pay.”

Like other older cities, Washington also grapples with obsolete combined sanitary and storm sewer systems—prone to overflowing in heavy rains—which serve much of the District, including the downtown.

To help reduce volumes during storm events, the water and sewer authority has instituted a highly praised stormwater rate structure, taxing property owners based on their amount of impervious surface (which produces stormwater), not the traditional method based on amount of potable water consumed. The idea is not only to raise money, but also to orient building and landscaping practices to limit runoff.

And despite its infrastructure challenges, the District boasts one of the world's most sophisticated wastewater treatment plants at Blue Plains, credited with helping clean up the once badly polluted Potomac River and its flows into the Chesapeake Bay.





Paying the Way





Ian Reid/Getty Images



Infrastructure in the United States can be likened to a 1995 Chevy Impala whose owner has lost his job and is trying to keep his house and the family fed. The car is dented and scratched and shows some rust. It's got plenty of mileage and doesn't get many miles to the gallon. But it still works even if the steering is a bit off and the oil leaks. For the owner, the car is the least of his

problems. He can still get around, do errands, and go to job interviews. It would be nice to buy a new model, but the money is just not there.

His unemployment check goes toward necessities—the mortgage, groceries, gasoline, and for that can of oil every month or so. It probably would be a good idea to spend

\$500 or \$1,000 on a valve job, if only for safety's sake. But he's busted. He assumes it won't break down, it'll keep going. But then what happens if the engine goes or the brakes fail?

Like the car owner, the President and Congress essentially duck dealing with long-term infrastructure issues. They focus instead on creating jobs, shoring up banks, paying for wars, damping health care costs, and arresting the housing market collapse. Drowning in red ink, states use Recovery Act cash to plug budget gaps and pay for transportation and water projects already in the pipeline, mostly for repairs and maintenance.

For their part, taxpayers hear the gigantic stimulus and bailout numbers—hundreds of billions of dollars of their money, maybe more than a trillion—and figure that must be enough to deal with whatever needs to be done. They worry about more spending and logically want to rein in deficits and cut costs—most people feel the tax burden is too much as it is.

In the end, the 2009 recovery bill will inject more than \$60 billion of federal funding into transportation- and water-related projects. That's not chicken feed, but it's not nearly enough to address the country's enormous five-year gap in infrastructure funding, estimated at more than \$1.1 trillion by the American Society of Engineers.

Move toward Merit

Enduring federal funding formulas continue to parcel out grants and funds without regard for merit or impact. By and large, the funding process doesn't encourage long-term infrastructure planning or ensure financing of major multimodal or multijurisdiction projects that could create efficiencies and improve productivity. But the rethinking of the federal surface transportation bill provides an opportunity to move toward merit, with **base** funds being used for system maintenance, **bonus** or discretionary grant funds for capacity expansions, and a new national infrastructure **bank** to make investment-grade decisions about infrastructure projects.

At least, with the federal Sustainable Communities Partnership, various federal agencies are beginning to discuss how to coordinate housing, transportation, and environmental policies. And a number of programs created and funded by stimulus (ARRA) dollars also show some silo-busting promise. The TIGER grants program, high-speed rail, and others are beginning a shift away from formulas to competitive, merit-based grants that encourage innovation and collaboration.

Under ARRA, the TIGER Discretionary Grants Program was allocated \$1.5 billion to distribute competitive grants worth \$20 million to \$300 million for transportation projects that create jobs and promote livability and sustainability. Signaling local hunger for innovative projects, TIGER received \$57 billion in grant requests from around the country. High-speed and commuter rail received \$8 billion in ARRA, and over \$50 billion in funding requests were received. The USDOT's assessment and award process for these programs can provide a new framework for making better decisions about where and how to invest major transportation dollars.

Federal Sustainable Communities Partnership and Livability Initiative

In June 2009, the U.S. Department of Housing and Urban Development, the U.S. Department of Transportation, and the U.S. Environmental Protection Agency announced a landmark partnership, promising to work together to integrate six “livability” principles into ongoing programming:

- provide more transportation choices;
- promote equitable, affordable housing;
- enhance economic competitiveness;
- support existing communities;
- coordinate policies and leverage investment; and
- value communities and neighborhoods.

Since the announcement, the agencies have been rolling out programs to put the principles into action. In late 2009, the Federal Transit Administration (FTA) rolled \$280 million in unallocated funds into two grant programs that use the livability principles to inform the grant criteria. In early 2010, the FTA announced that criteria for major new transit investments funded under the New Starts program would no longer focus exclusively on cost and time savings, but would instead account for livability factors such as economic development opportunities and environmental benefits.

Signaling an interest in Congress to codify the initiative and prevent rollbacks by a future administration, livability bills are being considered in both the House and the Senate.

Closing the Resource/Need Gap

For 2010, leftover stimulus money continues to fund various infrastructure upgrades and repairs, helping patch holes in state budgets. But the struggle to sustain basic services—let alone rebuild and build new infrastructure—appears to lose ground. Officials begin to worry about what happens when the stimulus runs out. Inevitably, large state and local government deficits and existing debt burdens will force spending cuts to balance budgets absent a sharp economic rebound. This is the case even though construction costs for infrastructure are lower now than they were two years ago—in some cases up to 30 percent lower. Advocating tax increases, meanwhile, has been the political equivalent of hara-kari.

Transit agencies in many cities cut schedules, close routes, furlough employees, and raise fares (up a whopping 17 percent at an annual rate in the last six months of 2009, according to the National Bureau of Labor Statistics). But higher fares contribute to reduced ridership (down nearly 4 percent in 2009) and decrease system revenues further, creating more budget shortfalls. Local officials, meanwhile, slow down or nix planned transit projects. In Denver, construction delays hit the Fastracks light-rail network expansion, and New York may slow down construction of the Second Avenue subway, a project first started and then halted in the 1970s during another budget crisis.

Compromised revenue sources constrain state and local transportation departments and water and sewer authorities—they will have more trouble maintaining, let alone improving, infrastructure. Water and sewer districts have no choice—they raise rates to pay for repairs and maintenance, but not enough for necessary upgrades. But increased user fees are inevitable.

The Future: More User Fees

Increased user fees will likely pay for infrastructure of all types over the next decade. At some point, out of necessity, elected officials will realize the user fee approach can most effectively and fairly raise money to fill the widening funding abyss, helping modify behaviors, which can improve productivity and eventually reduce overall costs to the economy. The country's few existing toll roads like the New York State Thruway have the ability to hike user fees and pay for necessary improvements and repairs, while other road networks can get neglected. In fact, the Thruway Authority currently budgets a whopping \$2.7 billion in necessary upgrades for the 640-mile (1,030-km) highway system.

Existing rate systems allow water and sewer authorities to raise rates and pay for repairs too, although most users resist major increases that could pay for major capital projects. "People have to start looking at water rates and tolls not as a tax, but as a fee for service and maintaining necessary systems." Greater angst likely will register in water-challenged places where pricing must adjust more dramatically to reflect limited availability and encourage conservation.

Enacting necessary user fee approaches will not be easy, especially in the midst of ongoing economic dislocation. A recent poll conducted by the nonprofit organization Building America's Future suggests that the public views infrastructure as a third-tier legislative priority well behind energy, health care, and education, although ahead of climate change. The data also indicate antipathy to any new fees or tolls and misconceptions about gas taxes—a majority of Americans think the gas tax increases annually. People are more likely to stomach tolls for new roads or congestion pricing than new tolls on existing highways, and they reject newfangled ideas like expensive-sounding vehicle mileage fees, which could charge for driving anywhere at any time.

Although people respond better to ideas for public/private partnerships and a U.S. infrastructure bank to help fund new systems and improvements, average citizens may miss the point that under any circumstances they will end up paying for investments through some combination of fees and taxes.

FIGURE 4-1

Time- and Location-Specific Fees Do the Best Job of Reflecting Marginal Costs

Rank	General Category	Examples
Best	Time- and location-specific road and parking pricing	Variable road pricing, location-specific emissions charges
Second Best	Mileage-pricing	Weight-distance charges, prorated motor vehicle taxes, mileage-based vehicle insurance
Third Best	Fuel charges	Increase fuel tax, carbon tax, apply general sales taxes to fuel
Bad	Fixed vehicle charges	Current motor vehicle taxes, vehicle purchase and ownership fees
Worst	External costs (not charged to motorists)	General taxes

Source: Adapted from paper by Todd Litman, Victoria Transport Policy Institute, 2010.

Vehicle Miles Traveled Tax

The gas tax looks more and more like an anachronism, especially with pending higher fuel standards, more hybrid cars, and possibly electric vehicles in the offing. The unpopular tax won't raise enough money unless it is hiked substantially, since many new vehicles all use less fuel.

To replace the gas tax, many interviewees favor establishing a straightforward system that charges drivers based on vehicle miles traveled—you pay more if you drive more and/or contribute more to congestion. Existing GPS and transponder technologies (like EasyPass) can be applied to compute mileage traveled as well as account for driving in rush hour congestion, HOT lane use, and bridge-tunnel fares. Heavy vehicles, gas guzzlers, and trucks would be charged more based on higher emissions and greater road wear and tear. Insurance rates can be linked more directly to mileage, too.

Drivers would be able to tally fully loaded driving expenses, including the cost for roads— theoretically, metering technologies can keep tabs on newfangled dashboard computer sys-

A man feeds one of Chicago's new "pay and display" parking meters. (AP)



tems. User fees would reduce significantly or eliminate government reliance on general taxes (income, sales, property) for roads and mass transit. Over time, people should pay less in total taxes and fees if they adopt lifestyles that involve less driving. Distance and time-of-day charges could make sense for public transit, too.

Of course, impacts could be felt across the board. Outer suburbs and American car culture could take a hit, because more people may look for less car-dependent lifestyles that favor infill locations and places with mass transit. Infill housing will cost more, because people will pay a premium for greater convenience and transit options. But higher housing costs should be offset by lower driving-related expenses (auto loans, insurance, repairs, as well as user fees), since families won't need to own as many cars if they can walk to trains and stores. Of course, it will take time, money, and patience for places without mass transit alternatives to adapt, and retrofitting into more pedestrian-friendly places and providing alternatives like light rail and bus rapid transit won't happen overnight.

Given congestion, pollution, productivity, and funding issues, people need incentives to drive less and government needs a source to pay for modern infrastructure, including mass transit, to keep people and goods moving as quickly as possible. "If user fees were implemented at full cost, we could encourage efficient behaviors and reduce general taxes used now to maintain systems." Inevitable innovation and multifaceted transport networks (roads, trains, buses, light rail, subways) could create efficiencies lost in chronic traffic jams.

Opponents of mileage-based user fees point to "Big Brother" issues—they claim the tracking could be invasive and reduce people's sense of freedom. But people's movements can be monitored already through cell phones and street highway cameras. "Over the next generation, people will become more comfortable with the idea." The bigger issue endures: "paying more" since "we haven't been paying enough." The alternative is crumbling infrastructure and a handicapped economy.

Smart Meters

Like mileage-based fees for driving, smart metering for electricity and water can help rate payers understand charges and encourage more efficient habits, which translate into smaller bills and less energy consumption. Smart electric meters show homeowners real-time billing costs—they can view kitchen monitors that register on graphs how running air conditioners and washing machines at peak summer hours escalates charges. Smart meters can also allow electric companies to adjust thermostats remotely to avoid brownouts, decreasing the number of required and expensive backup plants they must build. California leads the way in installing smart electric and gas meters—albeit without the remote control features, which homeowners complained might be too intrusive.

Smart water meters have the potential to enable greater conservation, especially in supply-constrained areas. The meters can help detect leaks and charge more for inefficient use—e.g., watering gardens in the middle of the day when evaporation rates are highest. As for the Big Brother remote control features, proponents figure that ratepayers eventually will embrace them once they become convinced about lowered bills.

China's Approach to Public/Private Partnerships

China keeps building infrastructure. More than 30,000 miles (48,280 km) of new highways have been built over the past 15 years, with another 20,000 miles (32,187 km) in construction or on the drawing board and plans to complete a 7,500-mile (12,070-km) plus high-speed rail network by the end of this decade. The spending and pace of development have been unprecedented, propelled recently by \$600 billion in stimulus funding, mostly directed at transport projects.

China is employing innovative capitalist tools to finance projects with private partners and establish profitable state-owned enterprises, which trade on major stock exchanges. The Chinese have applied "capitalism to socialism" and taken public/private partnerships to a new level, "allowing the government to share in the reward, not just the risk."

STATE-OWNED ENTERPRISES

Besides oil, phone, and electricity companies, Chinese state-owned enterprises include two major railroad construction entities—China Railway Engineering Corporation and China Railway Construction Corporation—as well as highway development and operating companies like Huabei Expressway Company Development Corporation.

The typical Chinese state-owned enterprise is a corporation formed by federal and provincial governments, with minority stakes held by private investors, including American hedge funds and private equity players. Huabei builds and operates the expressways around Beijing and successfully completed an initial public offering in 2005 on the Shenzhen Stock Exchange, where most state-owned corporations are traded. It has about a \$6 billion market capitalization, with 1.1 billion shares outstanding.

The company's revenues derive from not only tolls, but also subsidiary enterprises in auto repairs, auto leasing, consulting services, and real estate development. Revenues pay back financing from banks and provide shareholder dividends and are plowed into infrastructure upgrades and new projects. The company sells its services and expertise to other provinces within China, competing against other government-owned infrastructure enterprises. "The equivalent in the U.S. would be the New Jersey Department of Transportation contracting its services to Utah or some other state."

THE CHINESE MODEL

This Chinese public/private partnership model effectively turns Western infrastructure franchising concepts on their heads. Government, not private enterprise, takes the lead and risk/rewards are directly aligned between public and private partners. Revenue upside or project failure is shared between public and private shareholders, and the enterprise is structured to tap both private and public capital markets. The companies operate entrepreneurially to extend their services into markets both horizontally and vertically. They also don't depend on taxes or government subsidies to operate. Unlike U.S. interstates, virtually all of China's new highway system is tolled at rates averaging \$0.70 (¥5) for every six miles (10 km), with revenues flowing directly into the operating companies.

These Chinese enterprises also have advantages not shared by companies in Western democracies: authoritarian power to determine rights-of-way and access to cheap labor to help hold down project costs. NIMBY protests and union negotiations don't stand in the way of many road buildouts or rail lines in China.

PUTTING CHINESE ENGINEERS TO WORK

While Chinese government leaders, military officials, and well-placed bureaucrats reap significant incomes from managing state-owned corporations, these companies also have turned into magnets for highly skilled and well-paid engineers, who stand at the forefront of innovating technologies and systems for building state-of-the-art infrastructure. "For years, China sent its best and brightest overseas, including to the U.S., to learn from other countries," says an interviewee. "While top U.S. students went into investment banking to learn financial engineering, China molded engineers with skill sets to develop cutting-edge high-speed rail and mass transit. They're now trumping American ingenuity."

In the next step of their evolution, China's large railway construction companies have begun to export expertise and operations overseas, winning contracts to build projects in southeast Asia and Africa.

Public/Private Partnerships

Lurching PPP Momentum

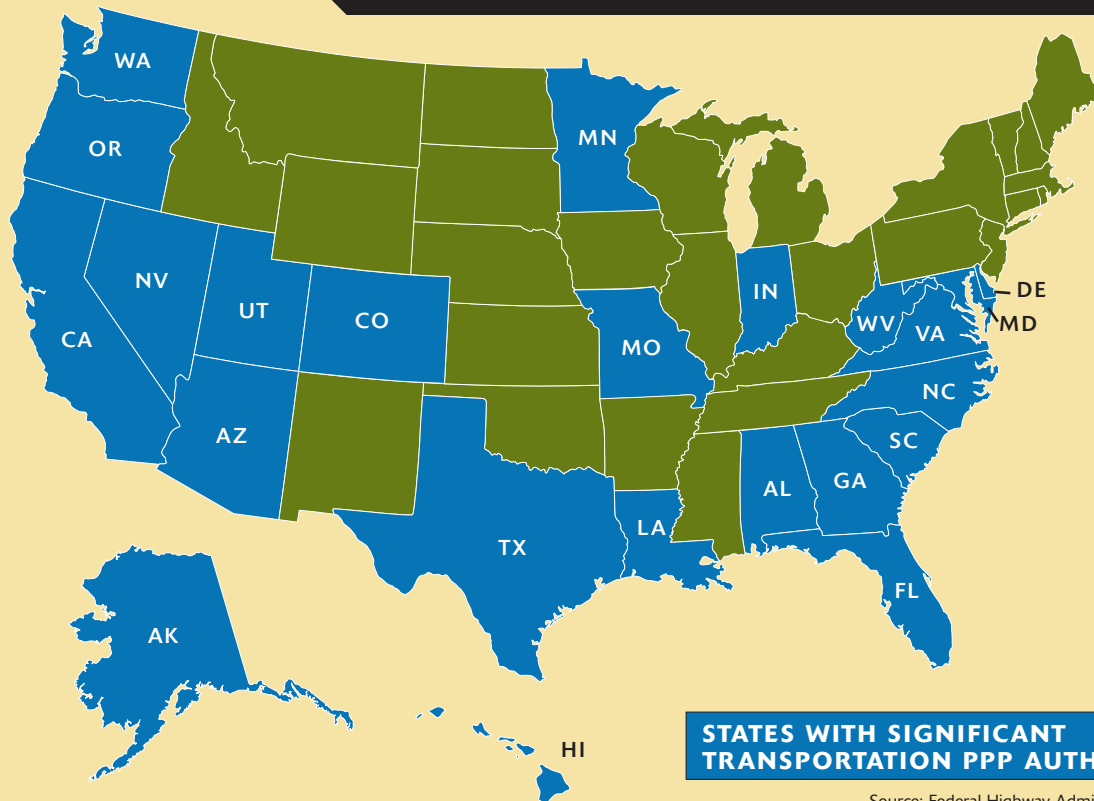
Although public/private partnerships (PPPs) have gained traction in Europe, Canada, and Australia, acceptance by U.S. state and local governments has been more problematic and spotty. “It’s been two steps forward, one step back.” The recent recession didn’t help, as investors retreated and governments retrenched. “Few major transportation projects move ahead—government fiscal problems and stimulus funding have created confusion, officials don’t see an easy way forward, and investors question where and whether to invest.” Foreign capital has been discouraged by the falling dollar, increasing government debt loads, and prospects for higher interest rates.

Nevertheless, several high-profile, “first of their kind” PPPs closed during the year and construction for another project is well underway. These transactions may offer guideposts for future U.S. public/private partnership deals:

- **IN FLORIDA**, the Department of Transportation entered into two separate agreements for constructing a \$2 billion tolled expressway expansion in south Florida (I-595) and a \$1 billion tunnel for the Port of Miami.

FIGURE 4-2

Some States Are Leading the Way in Passing Legislation Enabling Transportation Public/Private Partnerships



Source: Federal Highway Administration, 2009.



- **THE TEXAS DEPARTMENT OF TRANSPORTATION** and a private operator collaborated on building high-occupancy toll (HOT) lanes, part of a \$4 billion expansion and upgrade for I-635, a key highway at the center of the Dallas/Fort Worth Metroplex.
- **CONSTRUCTION CONTINUED ON A 14-MILE (22.5-KM) SECTION** of HOT lanes for the Capital Beltway (I-495) outside Washington, D.C., in Virginia. Slated to finish in 2013, the PPP budget is \$1.4 billion.
- **GEORGIA OFFICIALS INVITED PRIVATE FIRMS** to work in concert with the state to develop a framework for future availability payment deals.

While common in Europe and Canada, PPPs using an availability payment mechanism are just now drawing attention in the United States. Under varying terms, private sector concessionaires are paid for developing and operating a facility and keeping it “available” and ready for public use, while the public sector receives the revenues from any user fees. Greater government involvement in funding projects also gives operators a boost in attracting private financing and equity capital. “After early stumbles, these deals represent real progress—anticipate more to come.”

Overcoming Early PPP Missteps

Public/private partnerships don’t really change the cost equation for infrastructure—in the end, taxpayers and/or ratepayers must pay for building and maintaining systems. But if properly structured, PPPs can provide some advantages: bringing projects online faster (often at half the time of usual delivery methods), attracting investor capital to finance infrastructure projects, managing systems more efficiently, and employing innovative operating technologies faster than government agencies.

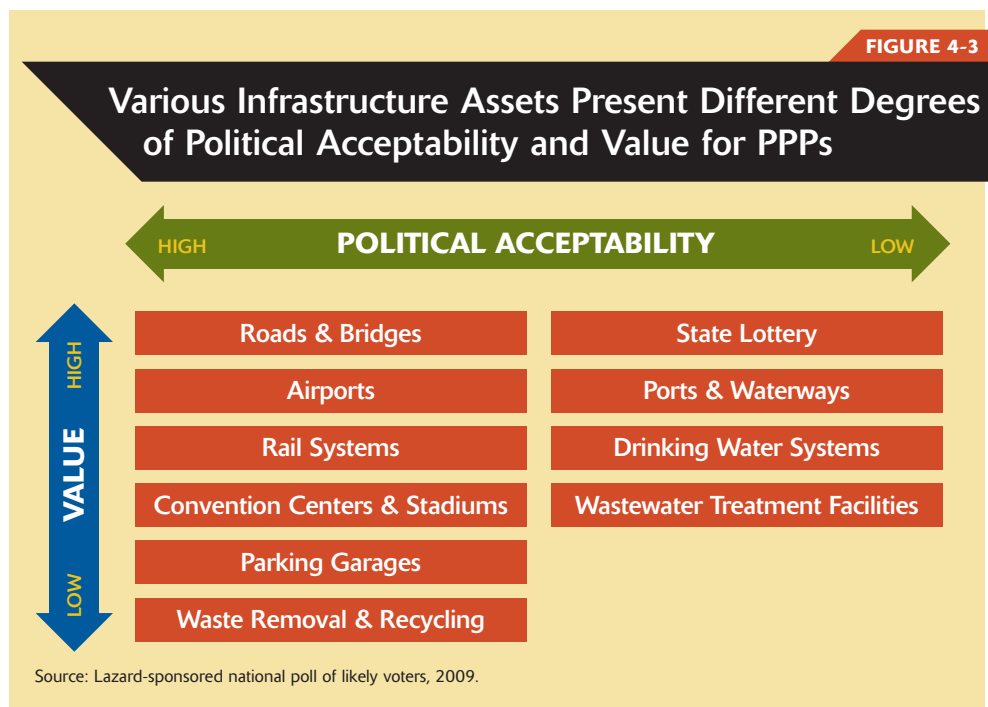
Some early high-profile brownfield PPP transactions in the United States “were bungled,” setting bad precedents. For example, some interviewees now question Chicago’s sale of long-term (75-year) franchises in its Skyway Bridge toll road and downtown parking in return for large lump sums used to close short-term funding holes in the city’s general budget. In 2009, early concerns about Chicago’s parking deal, in which the city gave up future revenues in return for \$1.15 billion, grew into widespread public outrage over maintenance problems coming on the heels of higher parking meter rates charged by the new concessionaire. In the midst of the credit crisis, the city’s agreement to sell an operating franchise for Midway Airport collapsed.

Balancing Interests

“Politicians like the PPP idea as a way to get immediate capital, but lose sight of assumption of risk,” says a leading transportation planner. “It’s too hard for them to raise taxes, and PPP approaches like franchises with long-term leases become a pathway for political expediency.”

Private operators and investors are in business to maximize profits and returns within the framework of their franchise agreements. They covet prime infrastructure monopolies—key bridges or highways, primary airports and seaports, water districts—where competition doesn’t threaten to undercut rate structures and facility demand ensures high volumes of users. “Government can’t forget that the private sector looks out for itself, not the greater whole.”

Concessionaires, for example, may resist initiatives for regional solutions involving multiple transport modes or jurisdiction consolidations—building a new passenger rail line parallel to their toll road franchise, constructing a competing bridge, or combining water and sewer districts to effect a broad-based water management plan. The heavy lift—managing and integrating land use, housing, transportation, water, and energy issues—remains very much in government’s court. The chart below describes the results of one public opinion poll, ranking different asset classes in terms of their political acceptability and value for PPPs.



PPPs in the Water Sector

Water offers a largely unexploited opportunity for public/private partnerships in the United States since rate paying formats exist and facilities badly need capital infusions for system upgrades. “Wastewater treatment is an area where the feds could put down a small amount of seed money alongside private investments and financing, which ratepayers would cover.” But investors get more “pop” from investing in toll roads and seaports than water. A “mismatch exists between private equity expectations for returns and water’s bondlike characteristics,” explains an interviewee. “The price of water needs to increase to get investors interested. That means ratepayers will have to pay more.” It’s a familiar refrain. PPPs must also overcome the public’s distrust of for-profit entities cutting corners in managing safe drinking water.



Water pumps at a purification plant are used to transfer freshwater from treatment units to storage tanks.

Why Not an Infrastructure Bank?

Establishing a U.S. national infrastructure bank could also lend support to PPP structures by drawing more private equity and debt capital into infrastructure development, as well as helping to establish voluntary, uniform frameworks across states for PPP structures. Investors like the security of side-by-side government funding and loan guarantees, but have been discouraged by uncertainty over ad hoc state approaches for soliciting PPP proposals. A federal infrastructure bank could help establish procurement protocols and standards, facilitating the bidding process.

If patterned on the European Investment Bank model, a U.S. version could “bring stability and long-term capital [15- to 25-year loans at low rates] to projects that require both,” and equity investors and commercial lenders “can get more comfortable before they dive in.”

The infrastructure bank proposal vetting process would also help introduce merit-based, competitive decision-making and provide a mechanism for funding major, cross-sector and multijurisdictional projects. But a U.S. infrastructure bank would be no silver bullet—in the end, infrastructure loans must be secured by some revenue stream—tolls, fees, increased rates, or taxes.

So far, Congress has not seriously pursued the infrastructure bank concept. Rescuing private lenders badly damaged in the banker meltdown has taken precedence, and, stung by the troubles at Fannie Mae and Freddie Mac, politicians reflexively shy away from the prospect of providing more backstops to financial institutions.

Private Infrastructure Investment Funds

Global infrastructure investment funds couldn't escape the fallout from frozen credit markets and global economic turmoil. Heavily leveraged funds that overpaid for asset concessions took “heavy” writedowns and face refinancing quandaries from broken loan covenants. Some late-in-the-game investment managers dropped plans to raise capital and abandoned the market.

Declining user fees have put some financing arrangements at risk. Investors in seaports, airports, and railroads experienced severe declines in revenues—traffic plunged 30 to 40 percent in some markets. Toll roads suffered revenue erosion too as drivers cut back trips. Water districts and regulated utility assets fared best, securing risk premiums for more predictable cash flows.

But surviving fund managers predict solidly improving prospects for 2010 and 2011. “We're rebounding strongly—equity is restoring in lower-leverage investments.” Travel and shipping volumes begin to revive. For new investments, capitalization rates will stay higher, reflecting perceived greater risk, and leverage will be harder to secure. “People now realize they paid too much” and chastened banks limit leverage to 50 to 60 percent, down from 80 percent or more at frenzied, anything-goes financing peaks. “But financing has come back.”

For institutional investors looking for predictable, long-term income streams, infrastructure investments in established concessions can beat risk/return prospects in the battered commercial real estate sector.

Congresswoman Rosa DeLauro Discusses an American Infrastructure Bank

Congresswoman Rosa DeLauro

(D-CT) represents Connecticut's Third District. In May 2009, she and more than 30 cosponsors introduced HR 2521, which would establish a national infrastructure development bank for the United States.



House of Representatives Photography Studio

Why do you support the concept of a national infrastructure bank?

Our infrastructure is crumbling. The American Society of Civil Engineers suggests that a \$2.2 trillion investment is needed in the next five years just to bring our infrastructure systems up to adequate condition. At the same time, we are emerging slowly from the worst economic recession since the Great Depression. Current federal programs cannot meet our investment needs in the areas of transportation, environmental, energy, and telecommunications

infrastructure, but interest is growing from global capital markets to invest in these areas. A national infrastructure development bank would leverage these private dollars to invest in critical infrastructure projects across the country.

How would the national infrastructure development bank, proposed in HR 2521, help address the need to boost investment in infrastructure in the United States?

We are seeing growth, albeit slower in the last year in light of the financial and economic crises, in a new infrastructure asset class with private equity funds and pension funds looking to invest in infrastructure. Right now, that funding is going overseas. China puts 9 percent of its GDP into infrastructure, India 5 percent and rising, while here in the United States we spend less than 2 percent of GDP on infrastructure. The federal government cannot meet the infrastructure investment deficit on its own, but with a national infrastructure bank we can begin to channel more private investment into our market and begin to rebuild America, create jobs, and spur economic growth that will keep us competitive in the 21st century.

How would a national infrastructure bank operate?

The bank envisioned in my legislation is modeled after the

European Investment Bank (EIB), with an independent and objective board of directors that would make final infrastructure financing determinations; an executive committee to handle the day-to-day operations of the bank; and risk management and audit committees to carefully manage risk and monitor the bank's activities. States, localities, and other entities would submit projects to the executive committee, which would then make funding recommendations to the board following a merit-based consideration of the projects. The board would have the power to issue bonds, provide loans and loan guarantees as well as other financing capabilities, looking to fund projects with the greatest economic, environmental, and social benefits.

How much money would the bank lend annually and would the amount be enough to make a dent in the nation's infrastructure needs?

As conceptualized in my legislation, the bank would have a total subscribed capital of \$250 billion, \$25 billion of which is provided through appropriations over five years and the rest subject to the call of the Treasury Secretary. The bank, like the EIB, would have a conservative leverage ratio of 2.5:1, allowing it to issue up to \$625 billion in 30-plus-year federal bonds. Ambassador Felix Rohatyn, a lead bank proponent, argues that such a self-supporting entity could easily provide up to \$250 billion in new capital over the next five years and perhaps significantly more over the longer term. That said, since infrastructure shortfalls require hundreds of billions in funds annually, the bank contribution would be just one piece of the investment puzzle, supplementing—not supplanting—other federal, state, and local funding sources.

Would the national infrastructure bank work with private financial institutions to fund projects?

Capital markets—including central banks, pension funds, financial institutions, sovereign wealth funds, and insurance companies—have a growing interest in infrastructure investment. One goal of the bank is to leverage that private interest into a U.S. infrastructure development market. The bank would consider private sector co-investment when it can help move the project along more promptly, provide a clear public benefit, and involve shared risks and returns. Private sector involvement in energy and telecommunications projects is well established, but with regard to public transportation the aim is not to sell the infra-



structure to private entities, but rather to create a true public/private partnership.

What types of projects will be eligible for bank funds?

The bank would consider infrastructure projects in transportation, the environment, energy, and telecommunications. Examples include providing financing for highway, transit, rail, air travel, drinking, and wastewater facilities; renewable energy transmission; building efficiency; green schools; and broadband expansion.

In particular, what types of water projects would an infrastructure bank help finance?

The Environmental Protection Agency projects that we need more than \$180 billion for installation and maintenance of drinking water transmission and distribution systems through 2022 and another \$200 billion for publicly owned wastewater systems through 2024. The bank would look at any drinking water and wastewater treatment facility, stormwater management system, dam, levee, open-space management system, solid waste disposal facility, hazardous waste facility, or industrial site cleanup. Water main breaks are an issue across the country—Baltimore alone has suffered more than 5,000 breaks in the last five years. Already supported by user fees, water projects can be a key area for bank financing.

How would projects be selected and by whom?

The bank's executive committee would conduct an analysis of economic, environmental, social benefits, and costs of each project under consideration, prioritizing projects that contribute to economic growth, lead to job creation, and are of regional or national significance. It would also consider specific criteria such as reduction in traffic congestion for transportation projects, public health benefits of environmental projects, reduction in carbon emissions for energy projects, and expansion of broadband and wireless services in rural and disadvantaged communities for telecommunications projects. The executive committee would be composed of experts in economic development, workforce development, public health, and finance.

What are the objections to an infrastructure bank?

The bank would represent a major public investment and opponents raise concerns about whether we need more spending or should instead focus on deficit reduction. I believe a national infrastructure bank can be a key component of long-term job creation and economic growth. The bank would also represent a new way to finance infrastructure projects, depoliticizing the process, breaking down jurisdictional silos in the federal government, and taking a holistic view of infrastructure projects.

Report Notes

CURRENCY

All currency is in U.S. dollars, unless otherwise noted. Foreign currencies were converted into U.S. dollars in February 2010.

FORUM

ULI conducted a forum to explore the connections between water availability and land use in the western United States in December 2009 in Las Vegas, Nevada. The symposium, "Adapting to a Drier West: Water, Growth, and Better Development Practices," highlighted the role of the development community in tackling pressing issues of water scarcity and management. The symposium was attended by 90 participants. Speakers included Deanna Archuleta, Deputy Assistant Secretary of the U.S. Department of the Interior, Michael Ogden, founding principal of Natural Systems International, as well as others.

QUOTES

ULI conducted 38 interviews with industry experts for this report. All unattributed quotes are from these interviews. The list of interviewees can be found on pages 87 and 88.

REGIONAL WATER ANALYSIS SURVEY

During the months of November and December 2009, ULI conducted a review of the water issues facing 14 metropolitan regions, including Atlanta, Boston, Chicago, Denver, Houston, Los Angeles, Miami-Dade, Minneapolis/St. Paul, New York, Philadelphia, Phoenix, San Francisco, Seattle, and Washington, D.C. The review involved interviews with key water stakeholders, including leaders of public utility agencies, wholesalers, and other water industry officials, and collection of water data and news reports on topics including waning water supply, budget constraints, regional coordination, aging infrastructure, and water conservation programs.

ACRONYMS

ARRA	American Recovery and Reinvestment Act of 2009
AVE	Alta Velocidad Española (Spanish for "high-speed train")
EIB	European Investment Bank
EPA	U.S. Environmental Protection Agency
EU	European Union
GDP	Gross Domestic Product
HOT	High Occupancy Toll
HSR	High-Speed Rail
HUD	U.S. Department of Housing and Urban Development
NIMBY	Not-In-My-Back-Yard
TGV	Train à Grande Vitesse (French for "high-speed train")
U.K.	United Kingdom
USDOT	U.S. Department of Transportation
PPP	Public/Private Partnership
U.A.E.	United Arab Emirates

INTERVIEWEES

Mary Sue Barrett

President
Metropolitan Planning Council, Chicago

Mark Bernstein

Director
University of Southern California Energy
Institute

Bruce Braine

Senior Vice President
American Electric Power, Columbus, Ohio

Ad Buisman

Partner
Ernst & Young, Netherlands

Shahid Chaudhry

Program Manager for Water-Energy Efficiency
California Energy Commission

Diane Clausen

Strategic Adviser
Seattle Public Utilities

Alexandra Davis

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ISBN: 978-0-87420-145-1
ULI Order #I21

