



FAILURE TO ACT



Economic Impacts of
Status Quo Investment
Across Infrastructure
Systems

Report Prepared by:



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ABOUT THE LONG-TERM INTERINDUSTRY FORECASTING TOOL

To estimate long-term national economic impacts, EBP used the Long-term Interindustry Forecasting Tool (LIFT), housed at University of Maryland's INFORUM Group. LIFT is a dynamic interindustry-macro (IM) model that uses macroeconomic data to examine how changes in one industry will affect other industries and the national economy.

The *LIFT* model captures the impacts of industry costs and productivity on industry prices and output, as well as variables such as real GDP and real disposable income. Baseline projections include population, household and labor force assumptions.

- Projections of population by age group are based on projections by the U.S. Census Bureau, the Social Security Administration (SSA), and the Centers for Medicare and Medicaid Services (CMS).
- Projections of labor force are based on labor force participation projections made by BLS (Bureau of Labor Statistics), combined with information from the latest CBO (Congressional Budget Office) 10-year and long-term outlooks.

Projections of federal and state and local consumption and investment in real terms are also important to the baseline scenario, and are developed using information from CBO, the Department of Defense, and consensus forecasts. Personal and corporate tax rates and social insurance contribution rates are an important influence on personal disposable income and to government surpluses or deficits. Various sources, including CBO, are consulted in specifying these tax and contribution rates. Also important are the large transfer payment programs, especially Social Security and Medicare, which are projected in terms of real benefits per qualified recipient. For these assumptions we rely on CBO, SSA and CMS.

Assumptions about the global economic outlook are important for determining demand for U.S. exports, and the prices of US imports. This information is taken from the Inforum Bilateral Trade Model, which includes models of other countries such as Germany, China, Japan, South Korea and Italy, as well as the bilateral trade flows (exports and imports) between those countries and the US. Several other assumptions are made to develop the Inforum *Lift* baseline, but these are the most important.



EXECUTIVE SUMMARY

Failure to Act: Economic Impacts of Status Quo Investment Across Infrastructure Systems

Every four years, the American Society of Civil Engineers (ASCE) publishes *The Report Card for America's Infrastructure*, which grades the current state of national infrastructure categories on a scale of A through F. In 2017, the U.S. infrastructure earned a D+ average. When the next Report Card is released in 2021, it will provide an updated look at the state of our infrastructure conditions, but there is also a larger question at stake – what are the implications of a low infrastructure grades for America's economic future?

This Failure to Act report answers the key question of how the conditions of the United States' infrastructure systems affect the nation's economic performance. The *Failure to Act* report provides this economic analysis by addressing 11 of ASCE's 17 infrastructure categories that are graded in the Report Card, as shown in Table 1. *Failure to Act* focuses on the incremental and gradual decline of infrastructure systems under current investment scenarios and shows that the impacts to our nation's economy are exacerbated over time as needed investments are deferred. Conversely, findings show that the positive economic impacts of infrastructure investment reverberate through every sector of the economy. Reliable, modern infrastructure is the underpinning of economic growth across communities.

ECONOMICS IN PANDEMICS: A NOTE ON COVID-19

The analysis in this report relies on baseline data that predates the COVID-19 pandemic. Data sets and economic models generally lag one to three years behind the present to allow for data collection, validation, and publication. As a result, a full set of economic data does not yet account for COVID-19 impacts. However, a key assumption for this study is that there will be a bounce back over the course of this 20-year analysis. Disruptions such as 9/11 and the 2008-2010 recession caused drops in jobs, income, and GDP, but the economy subsequently bounced back to pre-disruption levels and then continued to grow. In the short-term, infrastructure needs may change in response to the pandemic, but it is too early to forecast the extent or duration of those changes.

This report's economic modeling is based on the 2019 national economy. Therefore, the explicit assumption is that the U.S. economic performance that year absorbed the state of infrastructure as it existed, that deterioration of the current state of infrastructure will cause economic harm, and a more aggressive and wisely considered investment program will improve future economic performance.

These assumptions do not change in the wake of COVID-19. What does change are levels of the baseline economy and impacts considering the industries that are affected by the virus. For example, it is reasonable to think that the GDP shown in the baseline economic projection for 2039 may actually lag a few years as the nation recovers from pandemic-related impacts.

Table 1. Comparison of 2021 Report Card and Failure to Act Series

| 2021 Report Card | Included in Failure to Act Series |
|----------------------|-----------------------------------|
| Aviation | X |
| Bridges | X |
| Dams | |
| Drinking Water | X |
| Energy | X |
| Hazardous Waste | |
| Levees | |
| Inland Waterways | X |
| Ports | X |
| Parks and Recreation | |
| Rail | X |
| Roads | X |
| Schools | |
| Solid Waste | |
| Stormwater | X |
| Transit | X |
| Wastewater | X |

Note: The review of drinking water infrastructure in the Report Card includes reservoirs, which is not included in the Failure to Act Series

1. Summary

Infrastructure is the physical framework upon which the U.S. economy operates, and our standard of living depends. This framework enables us to move goods, power businesses of all sizes, connect people to jobs and services, heat and cool office buildings, and enjoy a glass of clean water.

The *Failure to Act* analyses compare current and projected needs for infrastructure investment against the current funding trends in surface transportation (highways, bridges, passenger rail, transit); water and wastewater; electricity; airports; seaports and inland waterways. Projections include costs of building new infrastructure where necessary, such as transmission lines or water treatment plants, and for maintaining or rebuilding existing infrastructure that needs repair or replacement. The total documented cumulative investment gap between projected needs and likely investment in these critical major infrastructure systems is more than \$2.6 trillion by 2029, and more than \$5.6 trillion by 2039. The long-term effects associated with infrastructure investments, long known to be a public safety issue, has a cascading impact on our nation's economy, impacting business productivity, GDP, employment, personal income, and international competitiveness.

Overall, if the investment gap is not addressed throughout the nation's infrastructure sectors, by 2039 the economy is expected to lose more than \$10.3 trillion in GDP. Losses are expected to include \$2.4 trillion in exports, while imports into the U.S. economy will decrease by about \$1.8 trillion, resulting in a \$4 trillion loss of trade, and a further increase of \$626 billion in our national trade deficit. As a result of this underperformance, job losses will mount annually, and in 2039, the U.S. economy is predicted to support 3 million fewer jobs than under baseline conditions.

Importantly, our report finds that if infrastructure investment continues at the current pace, American residents

and businesses will suffer. The expected impact for every household in the U.S will be an average loss of more than \$3,300 per year in disposable income through 2039.

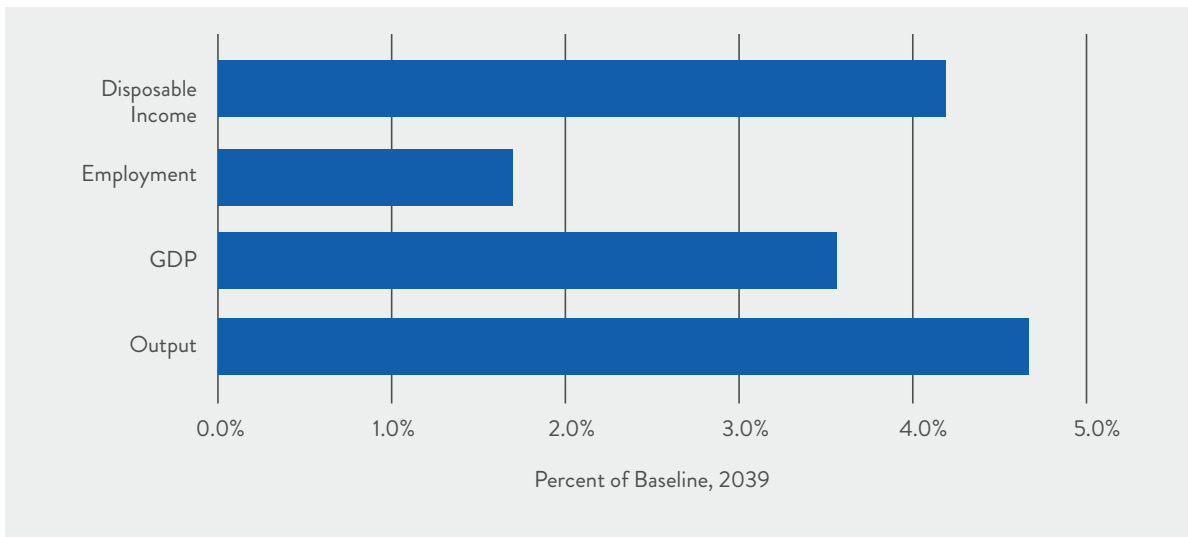
The categories of infrastructure systems addressed in the preceding *Failure to Act* analyses were reviewed in isolation. However, it is clear there is an interactive effect between different infrastructure sectors and a cumulative impact of ongoing investment gaps in multiple infrastructure systems. This final assessment examines those cumulative, interactive dynamics. Thus, regardless of how quickly goods can be offloaded at our nation's ports, if highway and rail infrastructure needed to transport those goods to market is congested, traffic will slow and costs to business will rise, creating a drag on our economy ultimately reflected in lower GDP.

The most important finding that is common to all analyses in this series is that infrastructure deterioration is progressive, and the economic effects will dramatically escalate over time from a business as usual approach. The good news is that much of the economic declines from worsening infrastructure, particularly those forecast from 2030–2039, can be prevented with thoughtful investment programs that address documented deficiencies.

However, under a trends-extended scenario of both projected infrastructure needs and investments, deficient infrastructure is expected to cost about 4% of the U.S. economy by 2039, as illustrated in Figure 1, including 4.6% of the nation's economic output, 4.2% of disposable household income and 3.5% of GDP, as well as 1.7% of the projected U.S. job base.¹

¹ Output represents gross production of U.S. industries. According to the U.S. Bureau of Economic Analysis, gross output consists of both the value of what is produced and then used by others in their production processes and the value of what is produced and sold to final users – that is, final product. Industry “value added” is defined as the value of the industry's sales to other industries and to final users minus the value of its purchases from other industries. Value added is a nonduplicative measure of production that when aggregated across all industries equals gross domestic product (GDP) for the economy.

Figure 1. The trends-extended deterioration of infrastructure is expected to affect 4% of the U.S. economy in 2039



Declines in output, GDP, disposable personal income and jobs reflect impacts against national baseline projections for 2039 and do not indicate declines from 2019 levels.

Sources: EBP and LIFT model, University of Maryland, INFORUM Group, 2020.

1.1 Purpose of this Report

This report analyzes the interactive effect between investment gaps in the infrastructure sectors addressed in each of the preceding studies. It presents an overall picture of national economic consequences of failing to fill the investment gap for all the infrastructure systems previously addressed.

Often, estimates of economic activity and job creation focus on the design and construction period for infrastructure projects, such as a project to rebuild an aging bridge. However, this study focuses on the incremental and gradual decline of infrastructure systems under current investment scenarios and shows that the negative impacts to our nation's economy exacerbate over time as needed investments are deferred.

The overall impact of deficient infrastructure associated with status quo investment levels cannot be estimated by simply adding the impacts found in each report because the degradation of surface transportation, water delivery and wastewater treatment, electricity, inland waterways and seaports each affect business productivity differently. Shifts to other production methods or modes of infrastructure may be

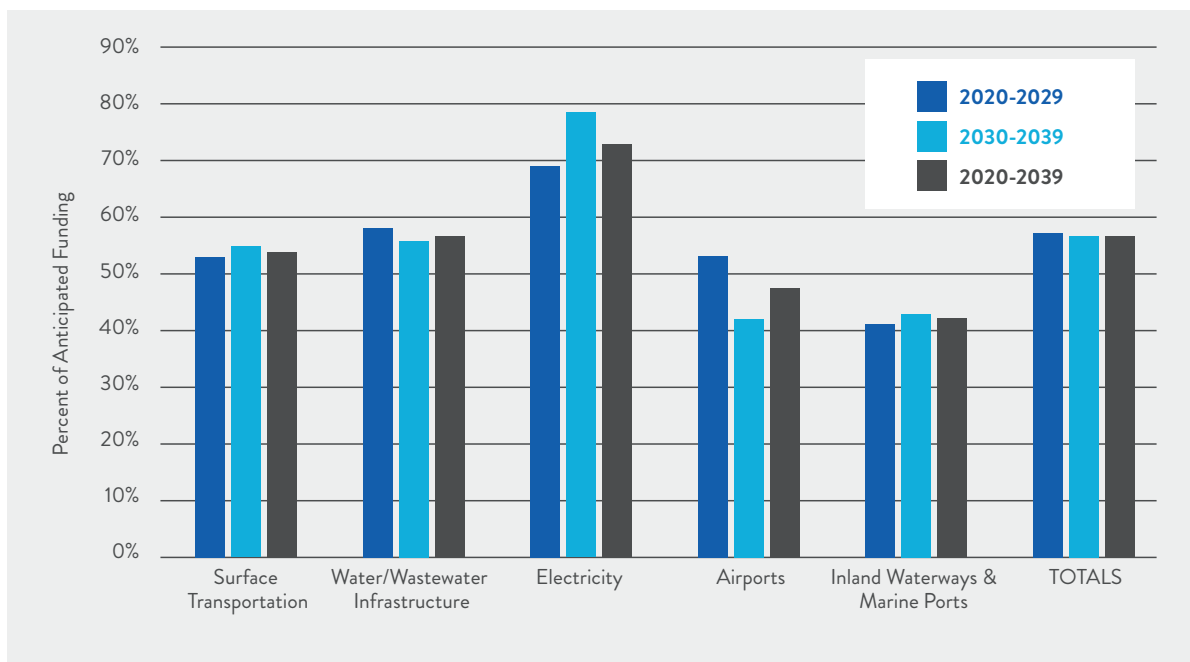
possible given a decline in one system, which could mitigate the economic impacts of failing to invest in that system. For instance, rail, inland waterways, and trucks are used to transport goods to retail shelves; deteriorating conditions in one sector tends to make the other sectors more price competitive. However, a general decline in infrastructure conditions across multiple sectors would preclude such strategies.

In addition, the consequences of infrastructure shortfalls differ by each system. With degrading surface transportation systems such as transit, trips can still occur, but they would take longer and be less reliable and safe. Declining airport and seaport infrastructure directly affect our nation's ability to import and export goods efficiently, driving up costs to U.S. consumers. Degraded reliability for electricity will affect production of goods, as well as stability of office-based and at-home professional services systems. Moreover, poorly operating water/wastewater systems will also affect business production and may even cause harm to public health. All aspects of infrastructure decay will also incur direct out-of-pocket costs for households across the U.S.

2. Economic Impacts of Failing to Invest Across Infrastructure Systems

Our trends-extended analyses indicate that funding will be available to cover only 57% (approximately \$3.5 trillion) of these needs through 2029, and 56.6% (\$7.3 trillion) by 2039 for the aggregate of surface transportation, water transportation, airports, water, wastewater, and electricity systems. This funding is compared to cumulative needs of \$6.1 trillion through 2029, which will increase to \$13 trillion by 2039. Thus, the investment gap totals more than \$2.6 trillion by 2029, and will grow to exceed \$5.6 trillion by 2039. As shown in Figure 2, the bulk of the gap is due to surface transportation needs, including roads, bridges, passenger rail, and transit systems. In addition, Figure 2 illustrates the percent of needs for each infrastructure type and the remaining unfunded investment gap.

Figure 2. Projected Funding by Infrastructure Category as Percent of Total Needs, 2020–2039



Source: EBP

The previous sector-specific Failure to Act studies found that the impacts of underinvesting in infrastructure will be higher costs to businesses and households because of less efficient and more costly infrastructure services. For example, travel times will lengthen with inefficient roadways, transit systems, and congested air service, and out of pocket expenditures to households and business costs will rise if the electricity grid or ports or inland waterways are unreliable. Goods will be more expensive to produce and more expensive to transport to retail shelves for households or to business customers. Business related travel, as well as commuting and personal trips, will also become more expensive. Consequently, U.S. businesses will be more inefficient compared to their global competitors. As costs rise, business productivity will fall, causing GDP to drop, cutting employment, and ultimately reducing personal income. Higher costs will also render U.S. goods and services less competitive internationally, reducing exports and decreasing dollars earned and brought into the U.S. from sales to international customers.

Impacts will be spread throughout the economy but will fall disproportionately on technology and knowledge-based industries that drive innovation and economic development. These include royalties for use of U.S. patents, knowledge-driven services such as architecture and engineering, and industries that support major components of our nation’s research and development such as aerospace, chemicals, and software.

While the U.S. economy will still be producing goods and services, it will do so at a reduced scale. Impacts will fall hardest on households as they pay more for services, including transportation, water and wastewater, and electricity, and absorb the brunt of fewer jobs, lower incomes, and higher prices for both domestically produced and imported goods. Ultimately, the fall in business sales due to the drop in exports, personal income, and consumer spending will reduce national GDP, which is a primary indicator of national economic productivity.

Table 2. Cumulative Infrastructure Needs by System based on Current Trends Extended to 2020 and 2039 (\$2019 billions)

| Infrastructure Systems | 2020-2029 | | | 2020-2039 | | |
|---------------------------------|----------------|----------------|----------------|-----------------|----------------|----------------|
| | Total Needs | Funded | Funding Gap | Total Needs | Funded | Funding Gap |
| Surface Transportation | \$2,574 | \$1,369 | \$1,205 | \$5,392 | \$2,902 | \$2,490 |
| Water/Wastewater Infrastructure | \$2,620 | \$1,531 | \$1,089 | \$5,754 | \$3,269 | \$2,485 |
| Electricity | \$637 | \$440 | \$197 | \$1,190 | \$872 | \$319 |
| Airports | \$237 | \$126 | \$111 | \$530 | \$249 | \$281 |
| Inland Waterways & Marine Ports | \$42 | \$17 | \$25 | \$84 | \$35 | \$49 |
| Totals | \$6,109 | \$3,483 | \$2,626 | \$12,950 | \$7,326 | \$5,623 |

Source: EBP

2.1 Impacts to Households

Businesses and households face higher costs due to several factors, including unreliable transportation services, less reliable water and electricity services, as well as unmet maintenance needs and outdated facilities for airports, seaports, and on inland waterways. These costs absorb funds from businesses that would otherwise be directed to investment or research and development and from households that would go towards discretionary consumer purchases. Thus, not only will business and personal income be lower, but more of that income will need to be diverted to infrastructure-related costs. This dynamic creates lower demand in key economic sectors associated with business investments for expansion and research and development, and in consumer sectors, such as housing, health care, restaurants and recreation, motor vehicles and others.

Compared to baseline forecasts for the years 2020 - 2039, the cumulative impact of deficient infrastructure due to continued underinvestment in the transportation, water, energy, and port sectors is predicted to result in an aggregated loss of \$23.3 trillion in total

output, including \$10.3 trillion in GDP from the U.S. economy. Losses are expected to include \$2.4 trillion in exports, while imports into the U.S. economy will decrease by about \$1.8 trillion, resulting in a \$4 trillion loss of trade, and a further increase of \$626 billion in our national trade deficit. As a result of this underperformance, job losses will mount annually, and by 2039, the U.S. economy is predicted to support 3 million fewer jobs than under baseline conditions.

The expected impact for every household in the U.S will be an average loss of more than \$3,300 per year through 2039, as shown in Table 3. These losses are due to job cutbacks and declining business productivity (which includes less sales and lower GDP), which will result in lower household incomes. Impacts will grow annually as poor infrastructure leads to mounting business losses and progressively lower wages. By 2029, each household is predicted to lose \$3,280, and household losses are expected to rise to \$6,710 by 2039 if trend-extended investment patterns persist (Figure 3).

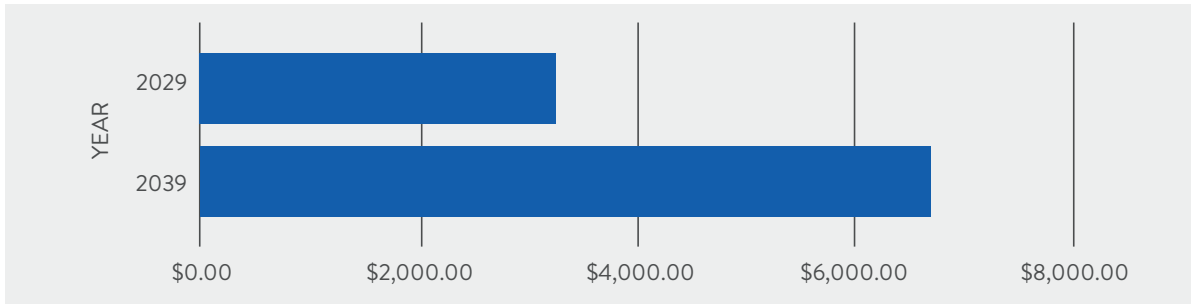
Table 3. Impacts of Infrastructure Investment Gap Per Household, 2020-2039 (\$2019)

| | 2020–2029 | 2030–2039 | 2020–2039 |
|---|-----------|-----------|-----------|
| Average Lost Annual Disposable Income Per Household | \$1,500 | \$5,400 | \$3,300 |
| Total Lost Disposable Income Per Household | \$14,600 | \$53,600 | \$66,600 |

Dollars rounded to nearest \$100. Totals may not multiply due to rounding.

Source: LIFT/Inforum Model of the University of Maryland, and EBP

Figure 3. Disposable Income Per Household (\$2019)



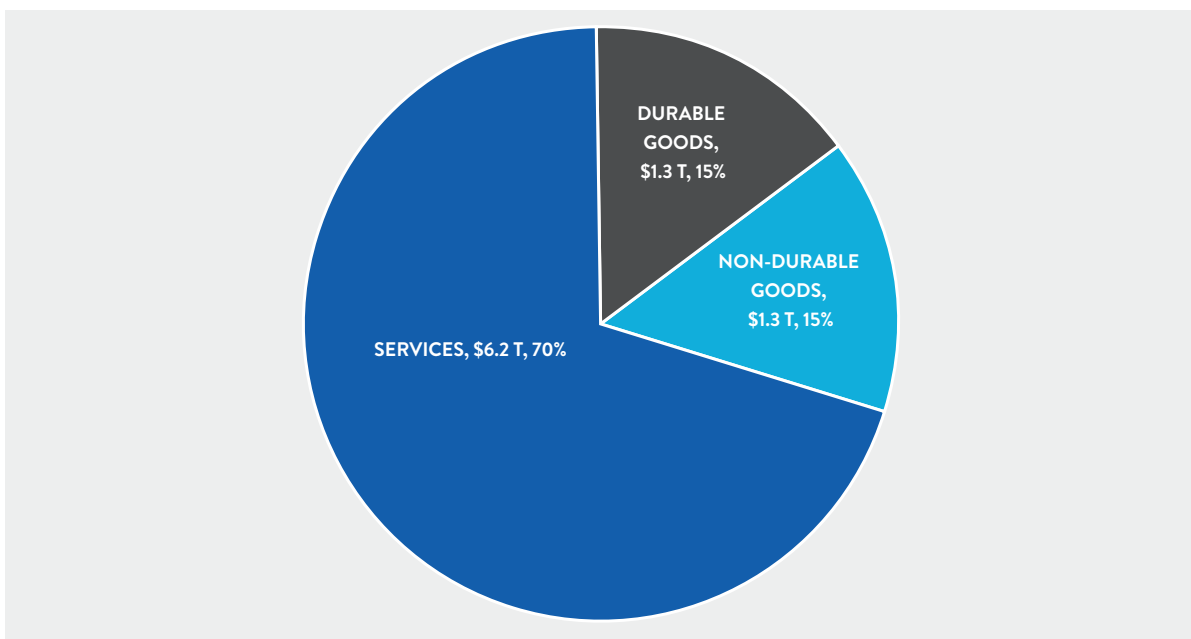
Source: LIFT/Inforum Model of the University of Maryland, and EBP

The lost income will lead to about a \$9 trillion decline in personal consumption across U.S. industries by 2039, which averages almost \$63,000 per household over 20 years. As displayed in Figure 4, about 30% of these foregone purchases will be in durable and non-durable manufactured goods and about 70% will be services.

Reduced expenditures will be particularly acute in

core human service industries related to housing and health care, and other quality of life sectors such as food services, accommodations, and recreation. Table 4 lists selected industries affected by the cumulative changes in consumption expenditures expected from 2020-2039. The reductions in expenditures indicate how households are expected to reprioritize expenditures to adapt to declining income.

Figure 4. Infrastructure Deterioration is Expected to Lead to a \$8.9 Trillion Decline in Personal Consumption, 2020–2039



Notes: Cumulative declines in personal consumption represent total consumption declines from 2020 through 2039. Losses reflect impacts against national baseline projections and do not indicate declines from 2019 levels.

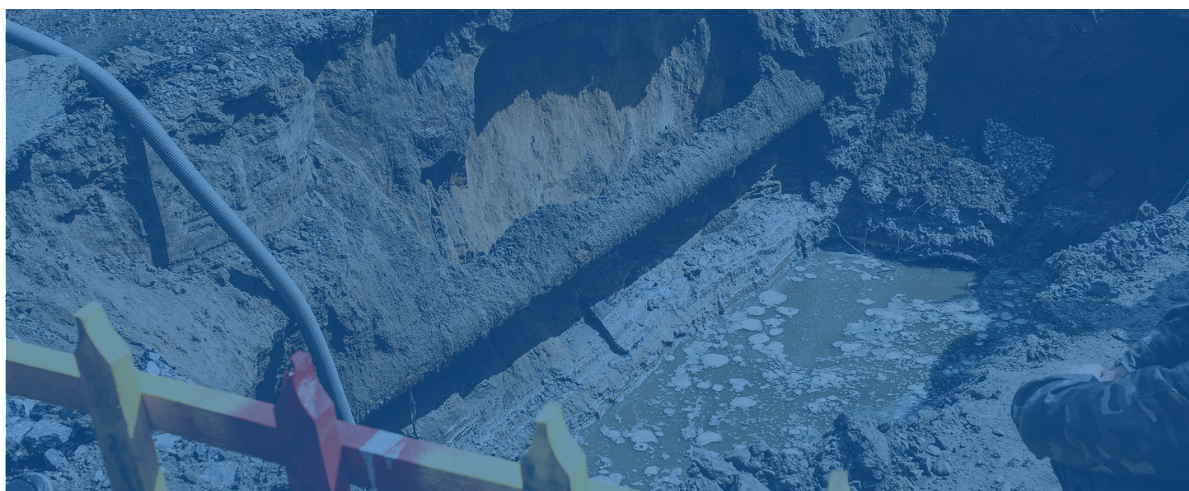
Sources: EBP and LIFT model, University of Maryland, INFORUM Group, 2020.

Table 4. Cumulative Personal Consumption Decreases by Selected Industry 2020-2039 (\$2019 billions)

| Sector | 2020-2029 | 2030-2039 | 2020-2039 |
|----------------------------------|----------------|----------------|----------------|
| Health Care | \$364 | \$1,603 | \$1,966 |
| Housing, Utilities | \$271 | \$909 | \$1,180 |
| Financial Services, Insurance | \$147 | \$427 | \$574 |
| Recreational Goods, Vehicles | \$89 | \$385 | \$474 |
| Transportation Services | \$98 | \$329 | \$427 |
| Food Services, Accommodations | \$81 | \$343 | \$424 |
| Recreation Services | \$78 | \$300 | \$378 |
| Food & Beverages, Off-Premise | \$64 | \$291 | \$354 |
| Furnishings, Household Equip. | \$80 | \$260 | \$340 |
| Clothing, Footwear | \$73 | \$245 | \$318 |
| Motor Vehicles, Parts | \$76 | \$231 | \$307 |
| Other Services | \$255 | \$989 | \$1,245 |
| Other Nondurable Goods and Fuels | \$141 | \$544 | \$685 |
| Other Durable Goods | \$47 | \$175 | \$222 |
| Totals | \$1,863 | \$7,031 | \$8,894 |

Notes: Cumulative losses represent the consumption declines from 2020 through 2039. Losses and increases reflect impacts against national baseline projections, and do not indicate changes from 2019 levels.

Sources: EBP and LIFT model, University of Maryland, INFORUM Group, 2020.



3. Detailed Impacts to the U.S. Economy

3.1 Total Economic Output Slows²

Gross output represents total national economic activity in producing and providing goods and services. Table 5 shows the total predicted output losses by industry sector due to status quo investment in infrastructure from 2020 to 2029 and 2030 to 2039.

Table 5. Aggregated Output Losses by Industry Sector (\$2019 billions)

| Sector | 2020-2029 | 2030-2039 | 2020-2039 |
|--|----------------|-----------------|-----------------|
| Manufacturing | \$921 | \$3,746 | \$4,667 |
| Health Care | \$340 | \$1,499 | \$1,840 |
| Professional Services | \$503 | \$2,363 | \$2,865 |
| Other Services | \$400 | \$1,559 | \$1,959 |
| Logistics | \$347 | \$1,443 | \$1,790 |
| Finance, Insurance and Real Estate | \$898 | \$3,401 | \$4,300 |
| Construction | \$157 | \$504 | \$661 |
| Retail Trade | \$234 | \$913 | \$1,147 |
| Accommodation, Food and Drinking Places | \$113 | \$485 | \$598 |
| Transportation Services (excluding truck transportation) | \$125 | \$501 | \$625 |
| Mining, Utilities, Agriculture | \$137 | \$553 | \$690 |
| Information | \$277 | \$1,292 | \$1,569 |
| Educational Services | \$46 | \$172 | \$219 |
| Entertainment | \$50 | \$217 | \$267 |
| Social Assistance | \$28 | \$125 | \$152 |
| Totals | \$4,576 | \$18,773 | \$23,350 |

Columns and rows may not add due to rounding.

Note: Losses and increases reflect impacts in a given year against national baseline projections.

These measures do not indicate declines from 2019 levels.

Sources: EBP and LIFT model, University of Maryland, INFORUM Group, 2020.

² Output represents gross production of U.S. industries. According the U.S. Bureau of Economic Analysis, gross output consists of both the value of what is produced and then used by others in their production processes and the value of what is produced and sold to final users – that is, final product. Industry “value added” is defined as the value of the industry’s sales to other industries and to final users minus the value of its purchases from other industries. Value added is a nonduplicative measure of production that when aggregated across all industries equals gross domestic product (GDP) for the economy.

As shown above in Table 5, manufacturing output is especially vulnerable to underinvestment in infrastructure. The production of manufactured goods – everything from paper, paints, food products, rubber, and asphalt to electronics, automobiles, and appliances – requires energy, many sectors require water, and all sectors require transportation of goods across the U.S. and to international markets. Table 6 presents the manufacturing sectors that are most vulnerable to a general decline by continuing with current in-

frastructure investment trends. The most affected manufacturing industries are forecasted to be chemicals, motor vehicles and food, beverage, and tobacco products (essentially, food processing). Together, these three sectors account for more than 40% of cumulative output of the manufacturing sector expected to be lost through 2039. The most vulnerable 10 manufacturing industries (of 19) account for more than 80% of expected output losses from the sector.

Table 6. Cumulative Projected Output Losses by Manufacturing Industry (\$2019 billions)

| Manufacturing Industry | 2020-2029 | 2030-2039 | 2020-2039 |
|--|--------------|----------------|----------------|
| Chemical products | \$150 | \$663 | \$813 |
| Motor vehicles, bodies and trailers, and parts | \$139 | \$508 | \$646 |
| Food and beverage and tobacco products | \$91 | \$416 | \$507 |
| Fabricated metal products | \$61 | \$254 | \$314 |
| Machinery | \$62 | \$251 | \$313 |
| Computer and electronic products | \$58 | \$244 | \$301 |
| Plastics and rubber products | \$49 | \$198 | \$246 |
| Other transportation equipment | \$46 | \$197 | \$243 |
| Primary metals | \$48 | \$190 | \$239 |
| Petroleum and coal products | \$48 | \$181 | \$228 |
| Other (9 Sectors) | \$170 | \$646 | \$815 |
| TOTAL | \$921 | \$3,746 | \$4,667 |

Columns and rows may not add due to rounding.

“Other” includes paper products, nonmetallic mineral products, electrical equipment, appliances, and components, wood products, furniture and related products, printing and related support activities, textile mills and textile product mills, apparel and leather and allied products, and miscellaneous manufacturing.

Note: Losses and increases reflect impacts in a given year against national baseline projections.

These measures do not indicate declines from 2019 levels.

Sources: EBP and LIFT model, University of Maryland, INFORUM Group, 2020.

3.2 Three Million Fewer Jobs by 2039, Nearly Half in High Wage Positions

Underinvestment in infrastructure will increase production costs, and therefore prices. This leads to a reduction in domestic demand, has implications on foreign demand, and reduces U.S. competitiveness. In turn, domestic production volumes fall, leading to lower levels of employment. Lower profits will lead to fewer people employed and lower wages paid to those still working, resulting in lower purchasing power by households and still fewer jobs supported by the economy, as shown in Table 7.

Table 7. Losses on Total U.S. Economy due to Inefficient Infrastructure Systems, 2020–2039 (\$2019 billions)

| Year | Business Sales (Output) | GDP | Disposable Income | Jobs |
|-----------------------------|-------------------------|---------|-------------------|-----------|
| Losses in the Year 2029 | \$1,032 | \$457 | \$460 | 1,481,000 |
| Losses in the Year 2039 | \$2,649 | \$1,130 | \$1,008 | 3,028,000 |
| Cumulative Losses 2020–2029 | \$4,576 | \$2,155 | \$2,016 | N/A |
| Cumulative Losses 2030–2039 | \$18,773 | \$8,124 | \$7,606 | N/A |

Columns may not add due to rounding.

Note: Losses and increases reflect impacts in a given year against national baseline projections. These measures do not indicate declines from 2019 levels.

Sources: EBP and LIFT model, University of Maryland, INFORUM Group, 2020.

Given current investment practices, capital investment needs, and changing trends in demand, the national losses in employment amount to almost 1.5 million jobs in the year 2029 and more than three million jobs by 2039.

Of note, about 47% of the projected jobs lost in 2039 will be in high wage and high production jobs including manufacturing, finance, insurance and real estate, professional services, and health care. In total, 220,000 jobs in manufacturing, 436,000 jobs in professional services and 581,000 jobs in health care will be lost by 2039. These industries include positions that support research and development and a highly educated workforce. Weakening these sectors will cause long-term harm to the national economy, stifling our ability to innovate.

Employment losses are slowed in part, by weakening labor productivity. Poor roads, for example, will require more drivers to navigate alternative routes. Similarly, 90-year-old lock and dam chambers on inland waterways require labor to disassemble modern barge tows at each lock and then to reassemble the tows. Thus, jobs in the logistics sector are projected to decrease slightly by 2029, but increase by 2039, because by 2039 job growth in truck transportation will outbalance modest declines in warehousing and the wholesale sector. Table 8 shows the total jobs beneath the 2029 and 2039 national baseline. Figure 5 illustrates the spread of expected job losses by sector in 2039.

**Table 8. Potential Job Losses or Gains (+)
Due to Inadequate Infrastructure, 2029 and 2039**

| Sector | 2029 | 2039 |
|--|------------------|------------------|
| Manufacturing | 120,000 | 220,000 |
| Finance, Insurance and Real Estate | 85,000 | 181,000 |
| Professional Services | 139,000 | 436,000 |
| Other Services | 276,000 | 562,000 |
| Health Care | 304,000 | 581,000 |
| Construction | 79,000 | 165,000 |
| Information | 31,000 | 70,000 |
| Logistics | 15,000 | +34,000 |
| Retail trade | 212,000 | 376,000 |
| Mining, Utilities, Agriculture | 12,000 | 19,000 |
| Transportation Services (excluding truck transportation) | 24,000 | 47,000 |
| Accommodation, Food and Drinking Places | 76,000 | 206,000 |
| Entertainment | 30,000 | 71,000 |
| Educational Services | 57,000 | 90,000 |
| Social Assistance | 21,000 | 36,000 |
| Totals | 1,481,000 | 3,028,000 |

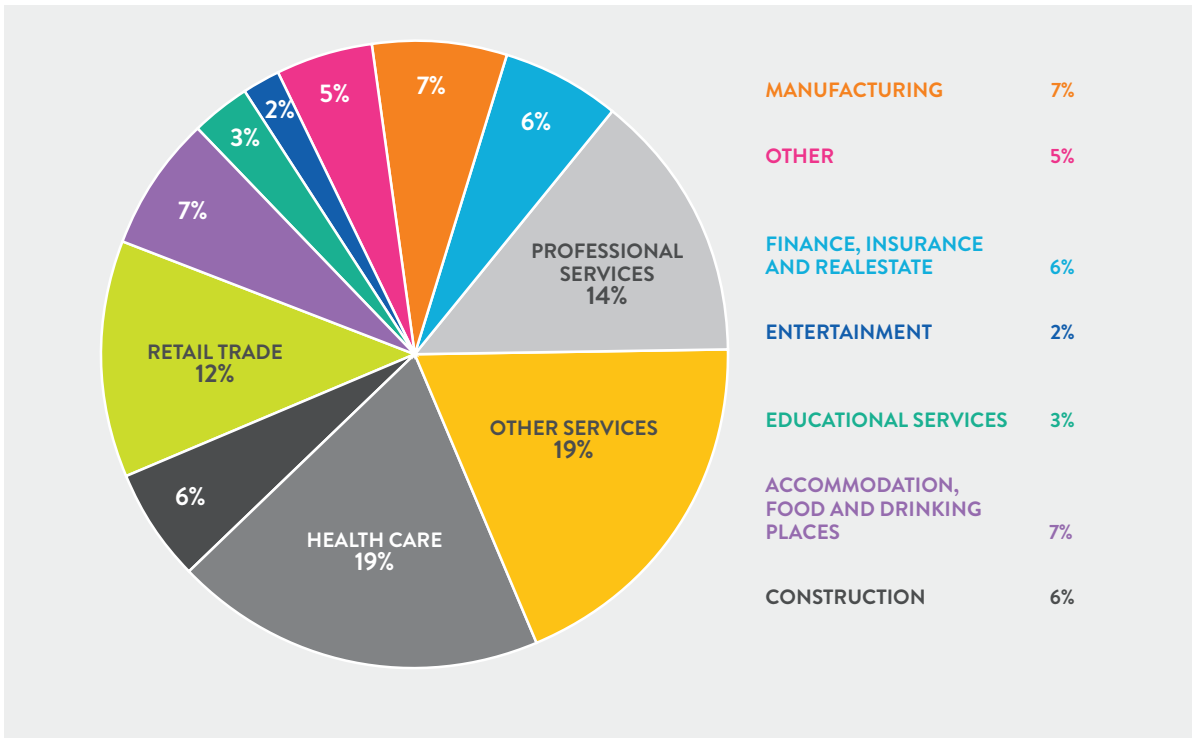
Columns and rows may not add due to rounding.

Note: Losses and increases reflect impacts in a given year against national baseline projections.

These measures do not indicate declines from 2019 levels.

Sources: EBP and LIFT model, University of Maryland, INFORUM Group, 2020.

**Figure 5. Sectors as Percent of Total Jobs
Beneath the 2039 National Baseline**



Note: Percentages are based on the proportion of jobs projected to be lost in 2039. Sectors that account for 3 percent or less of the expected losses are combined as “other” (information, logistics, transportation services, excluding trucking; mining, utilities and agriculture; and entertainment).

Sources: EBP and LIFT model, University of Maryland, INFORUM Group, 2020.



3.3 International Trade Falls by More than \$4 trillion

Extended time required to move commodities to ports and receive commodities from suppliers, rising incidences of unreliable water delivery and wastewater services—along with voltage surges, blackouts, and brownouts— all disrupt production and add costs to businesses. Without addressing these concerns, U.S. manufactured products will be less competitive in international markets. Consequently, between 2020 and 2039, U.S. businesses are forecast to lose approximately \$2.4 trillion in the value of its exports. At the same time, households and businesses will be purchasing less due to reduced personal and business income, and foreign imports will decline by \$1.8 trillion. In total, the national balance of the trade deficit is expected to increase by roughly \$626 billion in 2019 dollars. The balance of trade will be stable through 2029, but in the decade following, declines in exports will accelerate faster than declines in imports as the compounding effects of inefficient infrastructure take effect throughout the economy.

Table 9 shows the cumulative trade effects by quantifying the degree to which overall trade is expected to decrease. Table 10 lists the 15 exported goods and services that stand to lose the most money through 2029 and 2039 due to underperforming infrastructure.³ The decline in international trade is due to the jobs-related impacts of warehousing and storage, and wholesale trade noted above and profiled in Figure 4. These are the logistics sectors of the economy that are directly related to purchasing, selling, and stor-

ing goods that are imported and exported through U.S. coastal ports and airports. The decline in these logistics sectors will be driven by lower trade of manufactured, agricultural, and extracted products that require wholesaling and storage services. In addition, trade will be reduced in services, most notably royalties, which are licensing fees for use of a product or a patent and represent dollars earned due to export of our knowledge-based sectors.

Table 9. Cumulative Trade Effects (\$2019 billions)

| Period | Cumulative Export Decrease | Cumulative Import Decrease | Total Trade Decrease |
|------------------------------------|----------------------------|----------------------------|----------------------|
| 2020–2029 | \$381 | \$375 | \$755 |
| 2030–2039 | \$2,003 | \$1,383 | \$3,386 |
| Cumulative Losses 2020-2039 | \$2,383 | \$1,758 | \$4,141 |

Columns and rows may not add due to rounding. Losses and increases reflect impacts in a given year against total national export projections. These measures do not indicate declines from 2019 levels.

Sources: EBP and LIFT model, University of Maryland, INFORUM Group, 2020.

3 The LIFT model traces 121 goods and services commodities, including commodities sold by U.S. companies to international markets.

Table 10. Potential U.S. Export Reductions in Goods and Services by 2029 and 2039, Fifteen Largest Affected Sectors

| Export Sector | 2020–2029 | Export Sector | 2020–2039 |
|---|-----------|---|-----------|
| Wholesale trade | \$35.8 | Wholesale trade | \$233.9 |
| Motor vehicles | \$20.4 | Royalties | \$105.2 |
| Royalties | \$15.4 | Architectural, engineering and related services | \$92.2 |
| Aerospace products and parts | \$15.0 | Software | \$89.4 |
| Other chemicals | \$12.2 | Aerospace products and parts | \$89.3 |
| Architectural, engineering and related services | \$12.1 | Other chemicals | \$81.1 |
| Software | \$11.8 | Motor vehicles | \$78.6 |
| Other financial investment activities | \$11.0 | Other financial investment activities | \$77.8 |
| Scientific research and development services | \$9.4 | Scientific research and development services | \$71.2 |
| Other professional, scientific and technical services | \$8.3 | Other professional, scientific and technical services | \$58.7 |
| Petroleum and coal products | \$8.1 | Securities and commodities brokers | \$49.8 |
| Banks, credit cards and finance | \$7.2 | Banks, credit cards and finance | \$45.3 |
| Resin, synthetic rubber and fibers | \$6.9 | Petroleum and coal products | \$44.7 |
| Securities and commodities brokers | \$6.5 | Motion picture and sound recording | \$44.3 |
| Motion picture and sound recording | \$6.0 | Insurance | \$42.1 |

Note: Changes reflect impacts in a given year against national baseline projections by year from 2020 through 2039. These measures do not indicate changes from 2019 levels. Totals for pharmaceutical products and other chemicals are the sums of two commodity groups, “Pharmaceutical products” and “Other chemicals”.

Sources: EBP and LIFT model, University of Maryland, INFORUM Group, 2020.

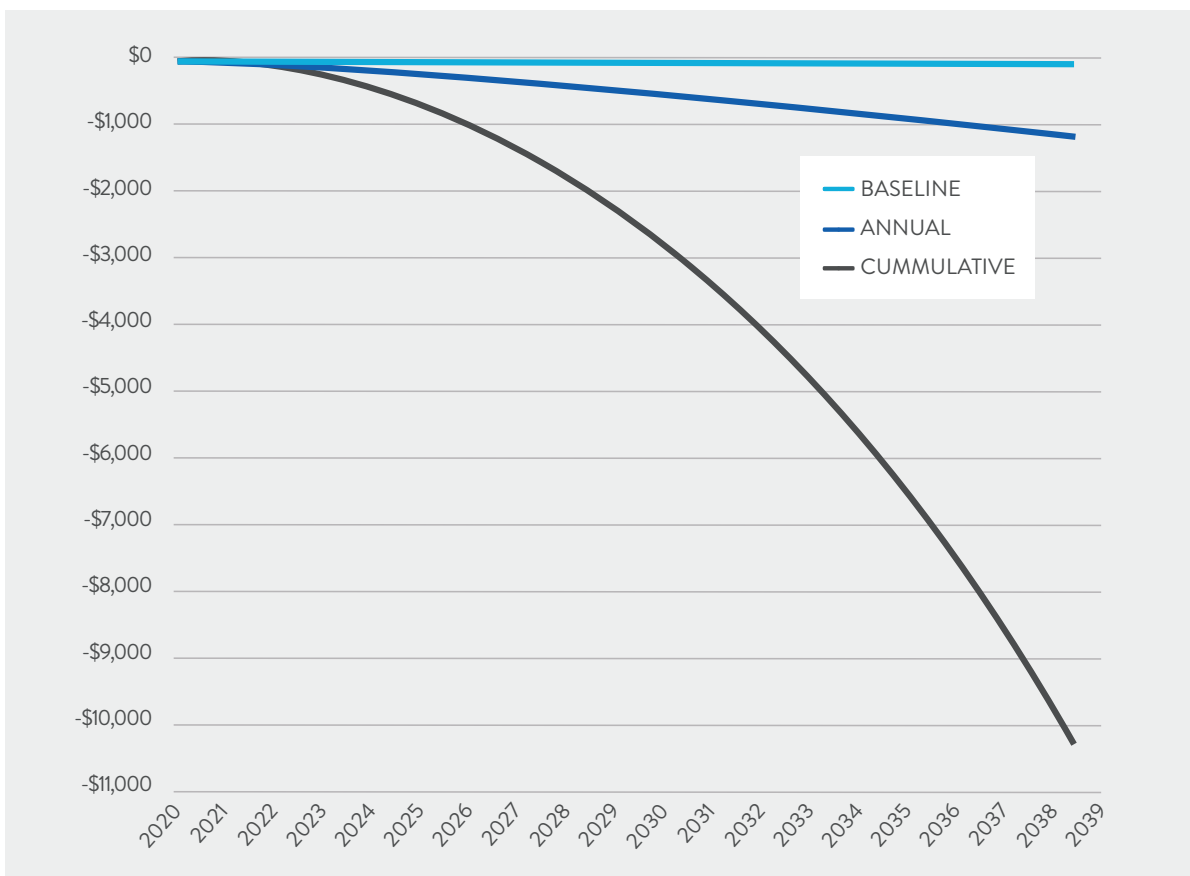
3.4 Compounding Effects

Of the total economic impacts projected from 2020–2039, more than three-quarters occur during the second decade of this study. About 80% of gross output losses, 79% of GDP declines and 78% of disposable income losses are expected to occur between 2030 and 2039. Additionally, 1.5 million jobs are projected to be lost in 2029 and 1.3 million jobs are forecast to be lost in 2039 due to deteriorating infrastructure systems. The annual cumulative nature of these declines is illustrated by Figure 6, which plots the yearly and cumulative losses of GDP from the U.S. economy.

As time goes on, the disadvantages that insufficient investment in infrastructure cause are compounded. Over the coming 10 years, economic declines are observed, but those declines worsen from 2030 to 2039. The delayed impact of underinvestment is harmful to much of the U.S. economy, particularly in manufacturing sectors. Our findings indicate that if the needs identified for 2020–2029 are not ad-

dressed and our national infrastructure systems do not become more modern, reliable, and resilient, business productivity will weaken, and wages and household income will fall. Therefore, domestic goods are expected to become more expensive to produce and U.S. consumers will have less purchasing power. These two factors will perpetuate a downward economic trend that will intensify over time.

Figure 6. U.S. GDP Impacts 2019–2039 from Decline in Infrastructure Services (\$2019 billions)



Note: Percentages are based on the proportion of jobs projected to be lost in 2039. Sectors that account for 3 percent or less of the expected losses are combined as “other” (information, logistics, transportation services, excluding trucking; mining, utilities and agriculture; and entertainment).

Sources: EBP and LIFT model, University of Maryland, INFORUM Group, 2020.

4. Conclusion

The U.S. economy relies on low transportation costs and the reliable delivery of clean water and electricity to businesses and households to offset higher wages and production costs when compared to many of our international competitors. However, the *Failure to Act* analyses show that business costs and prices will increase if surface transportation systems worsen, ports and inland waterways become outdated or congested, and if water, wastewater, and electricity infrastructure systems deteriorate or fail to keep up with changing demand. This report quantifies the national and regional trade-offs between increasing infrastructure investment and the broader economic consequences of inaction.

The analyses presented in the previous *Failure to Act* reports show that deteriorating infrastructure leads to reductions in business efficiencies, grows business costs and increases costs of goods and services to households. The results of these impacts are reduced levels of business sales, GDP, disposable household income, consumer spending and jobs.

Often, estimates of the economic implications of infrastructure investment focus on the design and construction period for infrastructure projects. Generally, in these types of analyses, the construction impacts rise with the magnitude of infrastructure investment. However, the *Failure to Act* analyses demonstrate that the economic benefits of infrastructure investment reverberate through every sector of the economy.

Findings from this final report show that weakening of multiple infrastructure systems will have a greater, compounding effect overall than simply adding the impacts for the individual infrastructure studies. Several core reasons explain this. First, if one transportation system fails, another system can sometimes be used. For example, if airports are too congested, passengers can drive or use trains, and cargo can be shipped by truck, rail, or inland waterways. However, this substitution is not possible if multiple systems deteriorate simultaneously. Moreover, every trip to

and from an airport, marine port and inland waterway port is by some form of surface transportation. Secondly, the efficient operations of different infrastructure systems depend on each other. For example, power plants use water to generate electricity (for boiling water to create steam and for cooling). Electricity and water are needed to manufacture parts for vehicle repairs and materials for road repairs. Transportation of all modes is required to deliver parts and equipment to all types of infrastructure systems, including other types of transportation facilities like airports. In addition, electrification is used for inter-city rail, as well as local transit guided bus ways.

Moreover, the most important finding that is common to all analyses in this series is that infrastructure deterioration is progressive, and the economic effects will dramatically escalate over time from the current “business as usual” approach. The good news is that much of the economic declines from worsening infrastructure, particularly those forecast from 2030–2039, can be prevented with thoughtful investment programs that address documented deficiencies. We must act today by increasing infrastructure investment across the board to remain economically competitive in tomorrow’s global marketplace.

A1 Appendix: Primary Sector

| Primary Sector | Sub-sectors |
|--|---|
| Manufacturing | Food and beverage and tobacco products, textile mills and textile product mills, apparel and leather and allied products, wood products, paper products, printing and related support activities, petroleum and coal products, chemical products, plastics and rubber products, nonmetallic mineral products, primary metals, fabricated metal products, machinery, computer and electronic products, electrical equipment, appliances and components, motor vehicles, bodies and trailers and parts, other transportation equipment, furniture and related products, miscellaneous manufacturing |
| Health Care | Ambulatory health care services, hospitals, nursing, and residential care facilities |
| Professional Services | Legal services, miscellaneous professional, scientific, and technical services, computer systems design and related services, management of companies and enterprises |
| Other Services | Administrative and support services, waste management and remediation services, and other services, except government, civilian government, which includes repair and maintenance services, personal services, household services, and non-profit organizations |
| Logistics | Wholesale trade, truck transportation, warehousing, and storage |
| Finance, Insurance and Real Estate | Federal reserve banks, credit intermediation, and related activities, securities, commodity contracts, and investments, insurance carriers and related activities, funds, trusts and other financial vehicles, housing services, other real estate, rental and leasing services and lessors of intangible assets |
| Construction | Construction |
| Retail trade | Retail trade |
| Accommodation, food, and Drinking Places | Accommodation, food services and drinking places |
| Transportation Services (excluding truck transportation) | Air transportation, rail transportation, water transportation, transit and ground passenger transportation, pipeline transportation, other transportation, and support activities |
| Mining, Utilities, Agriculture | Farms, forestry, fishing and related activities, oil and gas extraction, mining, except oil and gas, support activities for mining, utilities |
| Information | Publishing industries, except internet (includes software), motion picture and sound recording industries, broadcasting and telecommunications, data processing, internet publishing and other information services |
| Educational Services | Educational services |
| Entertainment | Performing arts, spectator sports, museums and related activities, amusements, gambling, and recreation industries |
| Social Assistance | Social assistance |

ABOUT THIS REPORT

This report considers the research and findings of five sector-specific economic studies, released by ASCE in 2020 and 2021, under the umbrella title “Failure to Act.” This series includes analysis on the nation’s water, wastewater and stormwater systems, surface transportation, electricity, airports, and marine ports / inland waterways. This report examines the implications for the national economy based on combined needs and investment trends.

A research team comprised of EBP, Downstream Strategies, Daymark Energy Advisors, and the Interindustry Forecasting Project at the University of Maryland (INFORUM) worked with ASCE to develop these studies.

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ABOUT EBP

EBP—formally Economic Development Research (EDR) Group—is a firm dedicated to advancing the state-of-the-art in economic evaluation and analysis to support planning and policy in the areas of transportation, energy resources, urban development, and economic growth strategy. Since its founding in 1996, EBP has helped state and local governments make infrastructure investment and economic development decisions that support broad-based job creation, income generation, and overall prosperity. ASCE contracted with EBP to conduct this study. To learn more: www.ebp-us.com/en

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