CHAPTER 1

Extent and Physical Condition of the U.S. Transportation System

Highlights

- The Nation's transportation assets were valued at approximately $7.7 trillion in 2013, an increase of 13.6 percent over 2010 estimates. Publicly owned infrastructure and equipment accounted for over one-half of transportation capital stock.
- Highway lane-miles increased slightly less than 1 percent between 2010 and 2013. Highway person-miles traveled and vehicle-miles traveled increased by 1.5 and 0.7 percent, respectively, over that period.
- The condition of the U.S. transportation infrastructure is improving, but additional work is needed. The percentage of structurally deficient bridges dropped from 12.0 percent in 2010 to 10.5 percent in 2013.
- One impact of bridge deterioration is reduced load limits. In 2013, 11.8 percent of all bridges had reduced load limits, which caused commercial vehicle operators to use smaller trucks or take circuitous routes, increasing their costs.
- The average age of the highway light-duty vehicle fleet increased by 28 percent over the 2000 to 2013 period and stood at about 11.4 years in 2013. The average age of commercial trucks is now 14.7 years, up from 12.5 years in 2007.
- The majority of airport runways (commercial service, reliever, and select general aviation) are in good condition; only 2 percent are considered poor.
- Railroad capital expenditures totaled $13.1 billion in 2013, more than double the spending in 2000.
- The average age of inland waterway navigation locks, adjusted for the date of the most recent rehabilitation, is more than 50 years.
- There is a general lack of data on vehicle and traffic control system condition, regardless of mode, and on most aspects of intermodal connections.

The U.S. transportation system serves nearly 319 million Americans—including those who may not own a vehicle or rarely travel. Transportation allows us to commute to work, obtain goods and services, call on family and friends, and visit distant places. It also drives our economy, connecting 7.5 million businesses with customers, suppliers, and workers [USDOC CENSUS 2015, USDOC OTTI]. The system allows almost 75 million foreign visitors to travel to our country, resulting in a sizable contribution to the U.S. economy. The system serves a large and diverse set of users, as highlighted in appendix C and described in box 1-A.

This chapter examines both the extent and condition of the principal transportation modes, including infrastructure, vehicles and control systems, and the estimated cost of keeping or bringing the system into a state of good repair. Interconnections that link one mode with one or more other modes are also important system elements, but a lack of public data on these connections prevents meaningful analysis of their condition.

Assets and Investments

Transportation capital stock includes structures (e.g., roadways, bridges, and stations) and equipment (e.g., automobiles, aircraft, and ships). According to the Bureau of Economic Analysis, U.S. transportation capital stock was valued at an estimated $7.7 trillion in 2013, an increase of about $923 billion (13.6 percent) over 2010 estimates.[1] Table 1-1 shows the estimated value of transportation capital stock increased steadily from 2000 to 2013.

Transportation assets are owned by both the public and private sectors. Freight railroad facilities and equipment are almost entirely owned by the private sector, while state and local governments own highways and bridges, airports, seaports, and transit structures. In

[1] Subtracted out from the reported totals are the amount of depreciation of aging equipment and structures and the value of assets taken out of service.

BOX 1-A Extent of the U.S. Transportation System

MOTOR VEHICLES AND PUBLIC ROADS: 2000, 2010, and 2013

Public Road and Street Mileage by Functional Type (miles)

	2000	2010	2013
Interstate	46,427	46,900	47,575
Other freeways and expressways	9,140	11,319	11,602
Other principal arterial	152,233	160,493	161,757
Minor arterial	227,364	242,815	243,872
Collectors	793,124	799,226	803,807
Local	2,707,934	2,806,322	2,846,848
TOTAL, mileage	**3,936,222**	**4,067,076**	**4,115,462**
Bridges	587,135	604,460	607,708
Lane-miles	8,224,245	8,581,158	8,656,070

Motor Vehicle Registrations by Type

	2000	2010	2013
Light-duty vehicle, short wheel base	U	190,202,782	184,497,490
Passenger car	133,621,420	U	U
Motorcycle	4,346,068	8,009,503	8,404,687
Light-duty vehicle, long wheel base	U	40,241,658	51,512,740
Other 2-axle 4-tire vehicles	79,084,979	U	U
Truck, single-unit 2-axle 6-tire or more	5,926,030	8,217,189	8,126,007
Truck, combination	2,096,619	2,552,865	2,471,349
Bus	746,125	846,051	864,549
TOTAL, registered vehicles	**225,821,241**	**250,070,048**	**255,876,822**

Person-Miles Traveled (PMT) (millions)

	2000	2010	2013
Light duty vehicle, short wheel base	U	2,814,055	2,882,221
Passenger cars	3,107,729	U	U
Motorcycle	15,463	19,886	21,937
Light duty vehicle, long wheel base	U	831,312	805,997
Other 2-axle 4-tire vehicles	851,762	U	U
Truck, single-unit 2-axle 6-tire or more	100,486	110,674	106,582
Truck, combination	161,238	175,911	168,436
Bus	313,897	292,319	321,544
TOTAL, highway PMT	**4,550,574**	**4,244,157**	**4,306,717**

Vehicle-Miles Traveled (VMT) (millions)

	2000	2010	2013
Light duty vehicle, short wheel-base	U	2,025,745	2,074,458
Passenger cars	1,600,287	U	U
Motorcycle	10,469	18,513	20,366
Light duty vehicle, long wheel-base	U	622,712	603,313
Other 2-axle 4-tire vehicles	923,059	U	U
Truck, single-unit 2-axle 6-tire or more	70,500	110,738	106,582
Truck, combination	135,020	175,789	168,436
Bus	7,590	13,770	15,167
TOTAL, highway VMT	**2,746,925**	**2,967,266**	**2,988,323**

KEY: U = Data are unavailable.

NOTES: PMT and VMT for 2000 are not comparable to data for later years. Motor bus and demand response figures are also included in the bus figure for highway.

SOURCES: **Vehicle Registrations, Public Roads and Street Mileages, Bridges, Lane-miles, Motor Vehicles, PMT, VMT**: U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA), Highway Statistics (multiple years), as cited in the USDOT. Bureau of Transportation Statistics (BTS). *National Transportation Statistics* (NTS). Tables 1-5, 1-6, 1-11, 1-28, 1-35, 1-40. Available at http://www.bts.gov/ as of June 2015.

continued next page

AIR: 2000, 2010, and 2013

Number of U.S. Airports

	2000	2010	2013
Public use	5,317	5,175	5,155
Private use	13,964	14,353	14,009
Military	U	274	289
TOTAL, airports	**19,281**	**19,802**	**19,453**

Number of U.S. Aircraft

	2000	2010	2013
General aviation aircraft	217,533	223,370	199,927
Commercial aircraft	7,826	7,185	6,733
TOTAL, aircraft	**225,359**	**230,555**	**206,660**
TOTAL pilots	**625,581**	**627,588**	**599,086**

Passenger Enplanements

	2000	2010	2013
Domestic flights	U	629,500,000	645,700,000
International flights of U.S. carriers	U	91,000,000	97,500,000
TOTAL, passenger enplanements	**U**	**720,500,000**	**743,200,000**

Passenger Miles (thousands)

	2000	2010	2013
Domestic, revenue passenger-miles (RPM)	U	552,900,000	577,900,000
International on U.S. carriers, RPM	U	245,200,000	262,500,000
TOTAL, air RPM	**U**	**798,000,000**	**840,400,000**

Ton-Miles (thousands)

	2000	2010	2013
Domestic, enplaned revenue ton-miles	U	12,500,000	12,400,000
International on U.S. carriers, enplaned revenue ton-miles	U	52,500,000	49,500,000
TOTAL, enplaned revenue ton-miles	**U**	**65,000,000**	**62,000,000**

NOTES: General aviation includes air taxis. Commerical aircraft includes mainline and regional aircraft.

SOURCES: **Airports and Aircraft**: U.S. Department of Transportation (USDOT). Federal Aviation Administration (FAA) as cited in USDOT, Bureau of Transportation Statistics, *National Transportation Statistics*.Tables 1-3 and 1-11. Available at http://www.bts.gov/ as of June 2015. **Pilots**: USDOT/FAA. FAA Aerospace Forecast, Fiscal Years (multiple issues). Available at www.faa.gov as of June 2015. **Passenger enplanements**: USDOT, Bureau of Transportation Statistics (BTS), Office of Airline Information (OAI), *T-100 market data*. Available at http://www.transtats.bts.gov/ as of June 2015. **RPM and Enplaned revenue ton-miles**: USDOT, BTS, OAI, T-100 Segment data. Available at http://www.transtats.bts.gov/ as of June 2015.

TRANSIT: REVENUE YEARS 2000, 2010, and 2013

Number of Transit Vehicles

	2000	2010	2013
Heavy rail cars	10,311	11,510	10,380
Commuter rail cars and locomotives	5,497	6,768	7,150
Light rail cars	1,306	2,096	2,842
TOTAL, rail transit vehicles	17,114	20,374	20,372
Motor bus	59,230	63,679	67,383
Demand response	22,087	33,555	31,433
Ferry boat	98	134	156
Other	7,607	17,932	17,637
TOTAL, non-rail transit vehicles	**89,022**	**115,300**	**116,609**
TOTAL, transit vehicles	**106,136**	**135,674**	**136,981**

Person-Miles (millions)

	2000	2010	2013
Heavy rail	13,844	16,407	18,005
Commuter rail	9,400	10,774	11,736
Light rail	1,339	2,173	2,565
TOTAL, rail transit PMT	24,583	29,353	32,305
Motor bus	18,999	20,739	21,414
Demand response	588	874	898
Ferry boat	298	389	402
Other	632	1,272	1,449
TOTAL, non-rail transit PMT	**20,517**	**23,274**	**24,162**
TOTAL, transit PMT	**45,100**	**52,627**	**56,467**

Unlinked Passenger Trips (billions)

	2000	2010	2013
Heavy rail	2.63	3.55	3.82
Commuter rail	0.41	0.46	0.48
Light rail	0.32	0.46	0.52
TOTAL, rail transit UPT	**3.36**	**4.47**	**4.81**
Motor bus	5.16	5.24	5.33
Demand response	0.07	0.10	0.11
Ferry boat	0.05	0.06	0.06
Other	0.08	0.10	0.09
TOTAL, non-rail transit UPT	**5.36**	**5.49**	**5.60**
TOTAL, transit UPT	**8.72**	**9.96**	**10.41**

NOTES: **Motor bus** includes Bus (MB), Commuter Bus (CB), Bus Rapid Transit (RB), and Trolley Bus (TB). **Light Rail** includes Light Rail (LR), Streetcar Rail (SR), and Hybrid Rail (YR). **Demand response** includes Demand Response (DR) and Demand Response Taxi (DT).
SOURCES: **Transit vehicles**: U.S. Department of Transportation (USDOT). Federal Transit Administration (FTA). National Transit Database (NTD) as cited in USDOT. Bureau of Transportation Statistics (BTS). *National Transportation Statistics* (NTS). Table 1-11. Available at http://www.bts.gov/ as of June 2015. **Person-miles traveled**: USDOT/FTA/NTD as cited in USDOT/BTS/NTS. Table 1-40. Available at http://www.bts.gov/ as of June 2015. **Unlinked passenger trips**: USDOT/FTA/NTD, Table 19. Available at http://www.ntdprogram.gov/ as of June 2015.

RAIL: FISCAL YEARS 2000, 2010, and 2013

Equipment and Mileage Operated by Amtrak

	2000	2010	2013
Locomotives	378	282	418
Passenger cars	1,894	1,274	1,447
System mileage	23,000	21,178	U
Stations	515	519	518 (2012)
Passengers (millions)	20.9	28.7	30.9
Passenger-miles traveled (millions)	5,498	6,420	6,810

Equipment and Mileage Operated by Class I

	2000	2010	2013
Locomotives	20,028	23,893	25,033
Freight cars	560,154	397,730	373,838
Car companies and shippers freight cars	688,194	809,544	873,679
System mileage	99,250	95,700	95,235
Ton-miles (trillions)	1.47	1.69	1.74

KEY: FY = Fiscal Year. U = Data are unavailable
NOTE: **Fiscal year** ending in September.
SOURCES: **Amtrak-Locomotives, Railcars, System mileage, Stations and Passenger-miles traveled**: Amtrak as cited in U.S. Department of Transportation (USDOT). Bureau of Transportation Statistics (BTS). *National Transportation Statistics* (NTS). Tables 1-1,1-7, 1-11, 1-40. Available at http://www.bts.gov/ as of June 2015. **Passengers**: USDOT, Federal Railroad Administration, Office of Safety Analysis, as cited in USDOT, BTS, *Multimodal Transportation Indicators*. Available at www.bts.gov as of June 2015. **Class I railroads-Locomotives, Freight cars, and System Mileage**: Association of American Railroads, Railroad Facts (Annual issues) as cited in USDOT/BTS/NTS. Tables 1-1, 1-11, 1-49. Available at http://www.bts.gov/ as of June 2015. **Ton-miles**: Association of American Railroads, Railroad Facts (Annual issues), as of June 2015.

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WATER: 2000, 2010, and 2013

	2000	2010	2013
U.S.-Flag privately owned merchant fleet (1,000 gross tons or over)	282	221	187
Recreational boats, millions	12.8	12.4	12.0
Lock chambers	276	239	239
Lock sites	230	193	193
Waterway facilities (including cargo handling docks)	9,309	8,060	8,231
Seaports (handling over 250,000 tons)	197	178	182
Miles of navigable waterways	25,000	25,000	25,000

U.S.-Flag Vessels

	2000	2010	2013
Barge/non-self-propelled vessels	33,152	31,412	31,081
Self-propelled vessels	8,202	9,078	8,918
TOTAL, Vessels	**41,354**	**40,512**	**39,999**

KEY: GT = Gross Tons.

NOTE: *U.S.-Flag privately owned merchant fleet* includes only oceangoing self-propelled, cargo-carrying vessels of 1,000 GT and above. Total, Vessels includes unclassified vessels.

SOURCES: **Fleet**: U.S. Army Corps of Engineers. Waterborne Commerce Statistics Center. Navigation Data Center. *Waterborne Transportation Lines of the United States* (Annual issues). Available at http://www.navigationdatacenter.us/ as of June 2015. **Recreational boats**: U.S. Department of Homeland Security. Coast Guard. *Recreational Boating Statistics* as cited in USDOT. BTS. *National Transportation Statistics*. Table 1-11. Available at http://www.bts.gov/ as of June 2015. **Waterways and Vessels**: U.S. Army Corps of Engineers. Institute for Water Resources. Navigation Data Center. The U.S. Waterway System: Transportation Facts and Information (Annual issues). as cited in USDOT. BTS. *National Transportation Statistics*. Tables 1-1 and 1-11. Available at http://www.bts.gov/ as of June 2015. **Locks, Facilities, and Seaports**: U.S. Army Corps of Engineers. Institute for Water Resources. Navigation Data Center. *The U.S. Waterway System: Transportation Facts and Information* (Annual issues). Available at http://www.navigationdatacenter.us/ as of June 2015.

PIPELINE: 2000, 2010, and 2013

Gas Distribution Systems Mileage

	2000	2010	2013
Distribution, main mileage	1,050,802	1,229,538	1,254,773
Distribution, estimated service mileage	737,298	872,384	894,609
TOTAL, gas distribution	**1,788,100**	**2,101,921**	**2,149,382**

Natural Gas Transmission & Gathering Systems Mileage

	2000	2010	2013
Onshore transmission	293,716	299,343	298,290
Offshore transmission	5,241	5,432	4,520
TOTAL, transmission	**298,957**	**304,775**	**302,811**
Onshore gathering	21,879	12,940	11,309
Offshore gathering	5,682	6,699	6,128
TOTAL, gathering	**27,561**	**19,640**	**17,437**
TOTAL, gas transmission & gathering	**326,518**	**324,415**	**320,248**

Hazardous Liquid or Carbon Dioxide Systems Mileage

	2000	2010	2013
Crude oil	U	54,631	60,902
Petroleum / refined products	U	64,787	63,533
Highly volatile liquids	U	57,980	62,742
CO2 or other	U	4,560	5,195
Fuel grade ethanol	U	16	16
TOTAL, hazardous liquid or CO2 systems	**U**	**181,974**	**192,388**

KEY: U = Data are unavailable

SOURCE: U.S. Department of Transportation, Pipeline Hazardous Material Safety Administration. *Annual Report Mileage Summary Statistics*. Available at http://www.phmsa.dot.gov/ as of June 2015.

total, publicly owned transportation accounted for over one-half of transportation capital stock; public highways and streets accounted for the largest share (42.6 percent) of this stock and much of the growth over the past few years. “Other” publicly owned transportation, such as airports, seaports, and transit structures, accounted for 8.7 percent.

In-house transportation is the largest category among the private-sector components. It accounted for 15.2 percent of transportation capital stock in 2013, most of which was highway related (e.g., truck fleets owned by grocery chains). Railroads, the next largest private sector category, accounted for 5.2 percent of U.S. transportation capital stock, followed by air with 3.0 percent. Motor vehicles owned by households and individuals, some of which are used for business purposes, accounted for 18.1 percent of capital stock.

The total value of public and private transportation construction put in place in 2014 was about $126 billion. Public transportation construction accounted for about $114 billion, or about 90 percent, of spending on transportation infrastructure [USDOC CENSUS 2014]. Approximately three-quarters of government-funded investment was for highways; the remainder supported the construction of transportation facilities and

TABLE 1-1 Estimated Value of Transportation Capital Stock by Mode: 2000 and 2010–2013

Billions of current dollars

	2000	2010	2011	2012	2013
Publicly owned capital stock					
Public highways and streets	1,398	2,880	3,075	3,207	3,284
Other publicly owned transportation	249	574	619	650	673
Privately owned capital stock					
Personal vehicles and parts	1,051	1,288	1,319	1,352	1,393
In-house transportation	820	985	1,040	1,106	1,173
Railroad transportation	288	360	376	391	399
Air transportation	185	220	225	229	234
Pipeline transportation	74	165	185	194	203
Other privately owned transportation	110	123	127	130	133
Commercial truck transportation	71	108	116	123	131
Private transit and ground passenger transportation	37	43	43	43	44
Water transportation	37	41	42	42	44
TOTAL	**4,319**	**6,787**	**7,166**	**7,468**	**7,710**

NOTES: Data include only privately owned capital stock except for those otherwise noted. Capital stock data are reported after deducting depreciation. *Personal vehicles* are considered consumer durable goods. *In-house transportation* includes transportation services provided within a firm whose main business is not transportation. For example, grocery companies often use their own truck fleets to move goods from their warehouses to their retail outlets. *In-house transportation* figures cover the the current cost net capital stock for fixed assets (e.g., autos, aircraft, ships, etc.) owned by a firm. *Other publicly owned transportation* includes publicly owned airway, waterway, and transit structures but does not include associated equipment. *Other privately owned transportation* includes sightseeing, couriers and messengers, and transportation support activities, such as freight transportation brokers. Details may not add to totals due to rounding. *Locks and dams* may be included under *Other publicly owned transportation*. Please see cited source for additional information.

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, *Fixed Asset Tables*, tables 3.1ES, 7.1B, 8.1; and *Nonresidential Detailed Estimates*, net stocks, current cost table. Available at http://www.bea.gov/ as of June 2015.

infrastructure such as airport terminals and runways, transit facilities, water transportation facilities, and pedestrian and bicycling infrastructure. In 2014 private transportation construction was about $12 billion, or about 10 percent, of spending on transportation infrastructure. Chapter 5 details transportation infrastructure spending and the revenues generated by each transportation mode.

Roads, Bridges, Vehicles, and Traffic Control Systems

Roads

Public roads, including interstate highways, other major arterials, and local routes, totaled 4.1 million miles in 2013, changing little from 2010 (as shown in box 1-A). Lane-miles increased slightly less than 1 percent over that period. Local roads are by far the most extensive, amounting to 2.8 million miles (69.2 percent of total system-miles). However, interstate highways, which accounted for about 47,600 miles (1.2 percent of total system miles), handled the highest volumes of traffic as measured by vehicle-miles traveled—24.8 percent in 2013 [USDOT FHWA 2014a]. Large Western and Midwestern states, such as Texas, California, Illinois, Kansas, and Minnesota, have the most public road mileage.[2] The District of Columbia, followed by Hawaii, Delaware, Rhode Island, and Vermont, had the lowest public road and street mileage [USDOT FHWA 2014a]. Figure 1-1 shows the annual average daily traffic on the National Highway System.

The U.S. Department of Transportation's (USDOT) Federal Highway Administration (FHWA) reports the International Roughness Index (IRI), which measures the smoothness of pavement and is a key indicator of the condition of highways and bridges.[3] Box 1-B provides summary data on the percentage of rough surface mileage for different functional classes of highways. The physical deterioration of roads and bridges typically does not produce abrupt failures; rather, continued rough riding produces repetitive and gradual increases in vehicle maintenance and other highway user costs.

In urban areas the results are mixed. From 2000 to 2013, interstate highways, other expressways, and other principal arterials had 1.4 to 4.2 percent reductions in the mileage of road surfaces with an IRI above 170. In contrast, over the same period, minor arterial and collector roads showed 4.6 and 1.4 percent increases, respectively, in the mileage of roads with an IRI above 170. The overall condition of all rural roadway categories improved between 2000 and 2011, with collectors showing the greatest improvement (3.5 percent), but all rural functional classes deteriorated over the ensuing 2 years. For both urban and rural roads as the functional class decreases from interstates down to collectors the percentage of rough roads increases, and this is true over the entire time period shown. This is likely the result of road maintenance and rehabilitation programs and budgets that favor the higher throughput classes of roadway.

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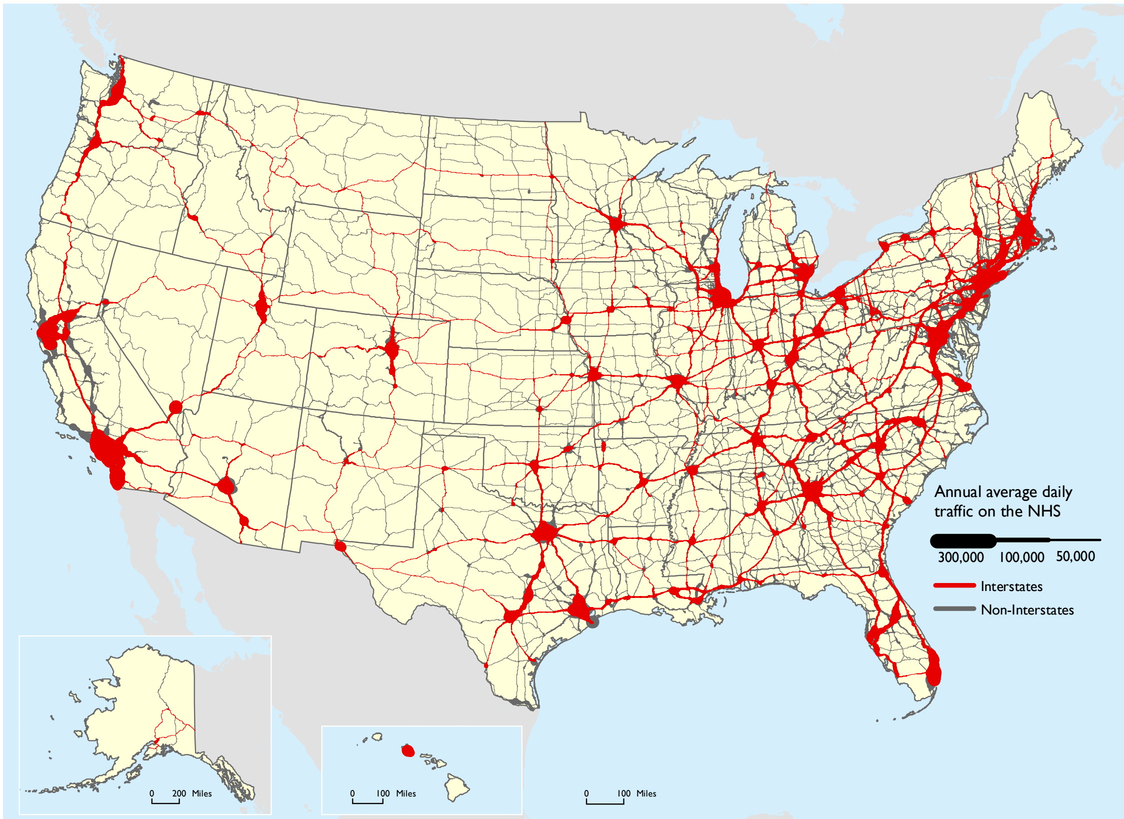
[2] Alaska, the largest state by land area, has relatively few miles of roads, which reflects the lightly populated and relatively undeveloped character of the large landmass that lies outside of the Anchorage to Fairbanks corridor.

[3] A highway that has a roughness rating greater than 170 inches per mile is considered in poor condition.

FIGURE 1-1 Annual Average Daily Traffic on the National Highway System: 2011



SOURCE: U.S. Department of Transportation, Federal Highway Administration, *Average Daily Traffic Volume*, available at http://www.fhwa.dot.gov/ as of April 2015.

Bridges

About 607,700 highway bridges were in use in 2013, ranging in size from rural one-lane bridges crossing creeks to urban multilane and multilevel interstate bridges. Rural local bridges accounted for about 33.4 percent of the total bridge network. By comparison, bridges in the urban and rural interstate system accounted for about 9.3 percent of all bridges in 2014, but they carried the highest volumes of motor vehicle traffic. Texas had the most bridges, accounting for 8.6 percent of the entire U.S. bridge network, followed by Ohio with 4.5 percent and Illinois with 4.4 percent [USDOT FHWA 2014b].

There has been slow but steady improvement in the condition of highway bridges, as shown in box 1-B. Two categories of bridge deficiency are tabulated: structurally deficient and functionally obsolete.

Structurally deficient bridges have reduced load bearing capacity due to the deterioration of one or more bridge elements. Such bridges are not necessarily unsafe, but they do require

Box 1-B Condition of the U.S. Transportation System

AIR: 2000, 2010, and 2013

Runway Condition and Aircraft Age

	2000	2010	2013
Airport runway condition			
All NPIAS Airports, percent			
Good condition	73	79	81
Fair condition	22	18	17
Poor condition	5	3	2
Commercial Service Airports, percent			
Good condition	79	82	83
Fair condition	19	16	15
Poor condition	2	2	2
Average age of aircraft			
Small commercial aircraft	NA	24.0	27.0
Major[a] airline aircraft	NA	14.1	13.3
National[a] airline aircraft	NA	9.1	11.6
Regional airline aircraft	NA	28.2	26.9

HIGHWAYS: 2000, 2010, and 2013

Highway Surface Condition

	2000	2011	2013
Percent of mileage with International Roughness Index[b] over 170			
Rural routes			
Interstates	2.1	1.8	2.4
Other principal arterials	4.0	3.2	4.9
Minor arterials	7.0	6.6	7.2
Collectors	22.1	18.6	19.7
Urban routes			
Interstates	6.5	5.2	5.1
Other freeways and expressways	10.9	7.8	7.2
Other principal arterials	30.0	28.1	25.8
Minor arterials	33.7	37.3	38.2
Collectors	52.3	53.7	53.7

Highway Bridge Condition and Vehicle Age

	2000	2010	2013
Condition of highway bridges, percent			
All structurally deficient bridges	15.2	12.0	10.5
Urban structurally deficient	10.2	8.3	7.0
Rural structurally deficient	16.7	13.3	11.7
All functionally obsolete	15.5	14.2	13.9
Urban functionally obsolete	25.2	24.2	23.8
Rural functionally obsolete	12.7	10.7	10.2

	2000	2010	2013
Average age of vehicles			
Passenger cars	9.1	10.8	11.4
Light trucks	8.4	10.5	11.3
All light vehicles	8.9	10.6	11.4

RAIL: 2000, 2010, and 2013

	2000	2010	2013
New rail and crossties laid			
Rail, thousand tons	690	564	620
Crossties, million	11.5	15.6	16.2
Age of locomotives, percent			
< 5 years old (2000 and 2010), < 9 years old (2013)	23.2	35.2	24.5
6-10 years old (2000 and 2010), 9-13 years old (2013)	13.2	10.0	17.0
11-15 years old (2000 and 2010), 14-18 years old (2013)	8.9	18.7	17.5
16-20 years old (2000 and 2010), 19-23 years old (2013)	12.0	17.9	9.4
> 20 years old (2000 and 2010), > 24 years old (2013)	42.6	18.2	31.6
Capital expenditures, $billion			
Roadway and structures	$4.55	$7.86	$9.32
Equipment	$1.51	$1.91	$3.77
Total	$6.06	$9.77	$13.09
Revenue ton-miles (billion)	1,466	1,691	1,741

TRANSIT (urban): 2000, 2010, and 2013

	2000	2010	2013
Average age of vehicles			
Heavy-rail passenger cars	22.9	18.7	20.2
Commuter-rail passenger coaches	16.9	18.9	20.8
Full-size transit buses	8.1	7.9	8.1
Light-rail vehicles	16.1	16.8	16.4
Transit vans	3.1	3.4	3.5
Ferry boats	25.6	20.5	21.4

WATER: 2000, 2010, and 2013

	2000	2010	2013
Age of locks			
Average age	50.2	59.5	62.5
Age of U.S. flag vessels, percent			
< 6 years old	19.6	18.5	19.3
6 to 10 years old	9.2	11.5	12.1
11 to 15 years old	5.1	17.0	14.3
16 to 20 years old	19.6	8.7	13.6
21 to 25 years old	18.3	4.2	7.7
> 25 years old	27.7	39.3	32.6

[a] Major carriers have annual operating revenue exceeding $1 billion. National carriers have annual operating revenues between $100 million and $1 billion. [b] International Roughness Index values are based on objective measurements of pavement roughness. A low IRI represents a smooth riding roadway.

KEY: NPIAS = National Plan of Integrated Airport Systems. NA = not available.

NOTES: Data is taken from multiple sources, thus the number of significant digits may vary. 2010 highway statistics are unavailable, thus 2011 was used.

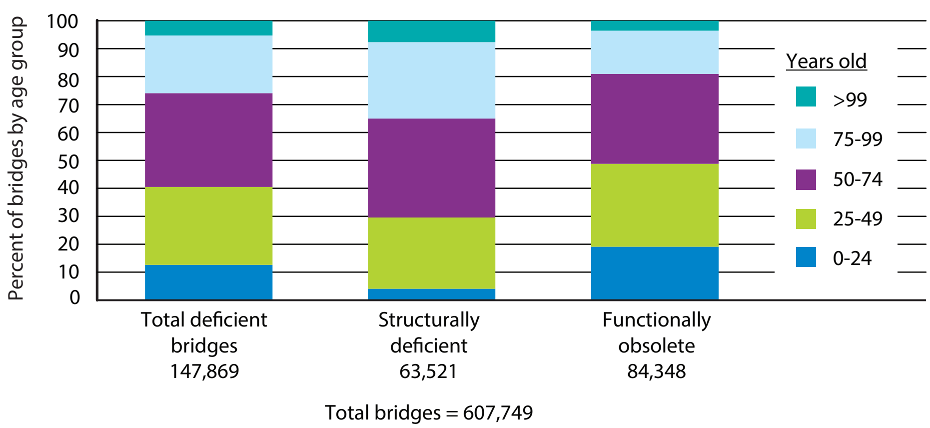
SOURCES: **Air**: U.S. Department of Transportation, Federal Aviation Administration, as cited in U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics (BTS), *National Transportation Statistics* (NTS), table 1-25. Available at www.bts.gov as of July 2015. USDOT, BTS, Office of Airline Information, TranStats Database, Form 41, Schedule B-43, special tabulation, July 2015. **Highways**: U.S. Department of Transportation, Federal Highway Administration, as reported in USDOT BTS NTS, op cit., table 1-26 (vehicles), table 1-27 (Highway surface condition), and table 1-28 (Bridges). **Rail**: Association of American Railroads, *Railroad Facts* (Washington, DC: annual issues). **Transit**: U.S. Department of Transportation, Federal Transit Administration, as reported in USDOT BTS NTS, op cit., table 1-29. **Water**: U.S. Army Corps of Engineers, Navigation Data Center, *General Characteristics of Locks and Waterborne Transportation Lines of the United States*. Available at www.ndc.iwr.usace.army.mil as of July 2015.

maintenance and repair to remain in service and will eventually require rehabilitation or replacement.

Functionally obsolete bridges, while structurally sound, often carry traffic volumes that exceed their design limits and may need to be widened or replaced. The percentages of both structurally deficient and functionally obsolete bridges declined from 2002 to 2013, with the largest declines recorded for rural bridges. Despite the improvement, 23.8 percent of urban bridges were functionally obsolete in 2013.

Figure 1-2 provides additional information on deficient bridges by age group, although age alone is not an automatic indicator of structural integrity. For example, the 132-year-old Brooklyn Bridge, due to consistent maintenance and several major rehabilitation projects, is still deemed safe for daily use, while the I-95 Mianus River Bridge in Connecticut collapsed in 1983 after only 25 years of service. The trend, however, is clear—the likelihood that a bridge will be found deficient increases with the age of the bridge. About 60 percent of deficient bridges are more than 50 years old, and one-half of bridges in place for 75 years or more are rated as deficient.

FIGURE 1-2 Bridge Condition by Age Group: 2013



	Years old (as of 12/31/2013)					
	0–24	**25–49**	**50–74**	**75–99**	**>99**	**All years**
Total bridges	**175,702**	**215,605**	**140,696**	**64,083**	**11,663**	**607,749**
Total deficient bridges						
Number	18,680	41,231	49,646	30,445	7,867	147,869
Percent	10.6	19.1	35.3	47.5	67.5	24.3%
Structurally deficient						
Number	2,576	16,200	22,491	17,388	4,866	63,521
Percent	1.5	7.5	16.0	27.1	41.7	10.5%
Functionally obsolete						
Number	16,104	25,031	27,155	13,057	3,001	84,348
Percent	9.2	11.6	19.3	20.4	25.7	13.9%

SOURCE: U.S. Department of Transportation, Federal Highway Administration, *National Bridge Inventory*, available at https://www.fhwa.dot.gov/bridge/nbi.cfm as of June 2015.

The more prevalent negative impact of bridge deterioration is the imposition of reduced load limits. In 2013 there were 71,692 bridges in the National Bridge Inventory with some type of load restriction, comprising 11.8 percent of all bridges listed [USDOT FHWA 2014b]. These load limit reductions can cause commercial vehicle operators to either use trucks with smaller payloads or take circuitous routes, both of which increase costs.

Vehicles

Government, businesses, private individuals, and nongovernmental organizations owned and operated about 256 million motor vehicles in 2013, up by 2.3 percent from 2010 levels (box 1-A). Motor vehicle registrations rebounded from the economic recession that began in December 2007 and continued to increase through June 2009 [NBER 2013], but remained slightly below the peak set in 2008.

Motor vehicle registrations have grown at a faster rate than licensed drivers and the population since the 1960s (figure 1-3). This growth produced an increase in the average number of motor vehicles owned by households. While U.S. vehicle registrations have changed very little since 2005, the same is not true for rapidly industrializing countries. For example, vehicle registrations in China grew from 31 million to 109 million over the 2005 to 2012 period and presently account for about 10 percent of the world total, up from 3.5 percent in 2005 [USDOE ORNL 2014].

Increases in vehicle registrations from 2010 to 2013 varied widely by vehicle type. For example, among passenger vehicles, registrations for light-duty short-wheelbase vehicles[4] decreased by 3 percent, while those for light-duty long-wheelbase vehicles[5] increased by 28 percent. Motorcycle registrations rose by 5 percent, continuing a long-term upward trend.

The numbers of single-unit and combination trucks registrations were down 1.1 and 3.2 percent, respectively, between 2010 and 2013. According to the U.S. Census Bureau's 2012 Economic Census, many of these vehicles were operated by the more than 111,200 trucking establishments[6] in the United States. Between the Census Bureau's 2007 and 2012 Economic Census, a period of time that included the December 2007 through June 2009 recession, the number of trucking establishments decreased by 7.6 percent [USDOC CENSUS 2012].

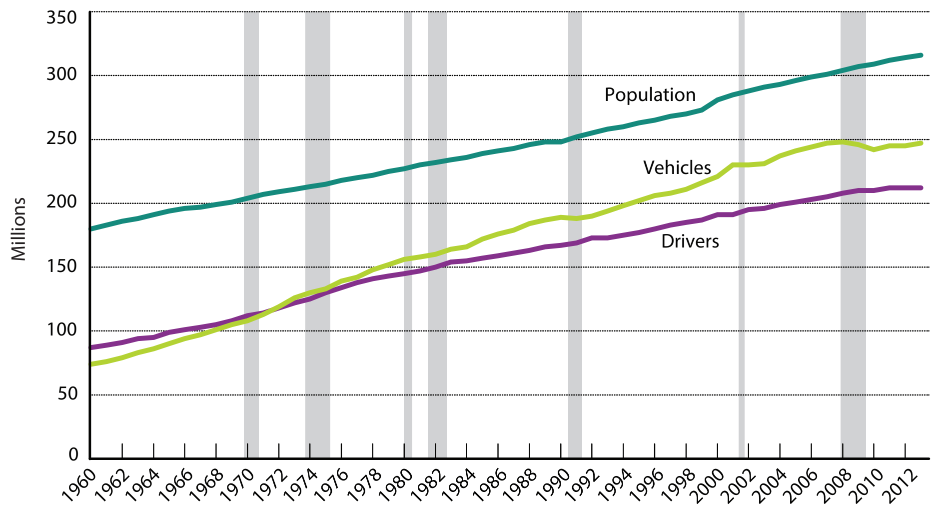
The number of buses increased by 2.1 percent between 2010 and 2013. Bus registrations grew fairly steadily from 2000 to 2010 and, after a temporary dip, now stand at their highest level over the period shown. Buses owned by schools, churches, and other groups accounted for 83 percent of the registrations in 2013 [USDOT FHWA 2014a]. About 3,500 carriers operated nearly 33,000 motorcoaches (or over-the-road buses) in the United States in 2013 [ABA 2015]. The motor coach industry is discussed further in chapter 2.

[4] Light duty vehicle, short wheel base includes passenger cars, light trucks, vans, and sport utility vehicles with a wheelbase equal to or less than 121 inches.

[5] Light duty vehicle, long wheel base includes large passenger cars, vans, pickup trucks, and sport/utility vehicles with wheelbases larger than 121 inches.

[6] There are over 500,000 interstate freight carriers registered with the U.S. DOT, which includes many private carriers operated by firms whose primary business classification is not transportation.

FIGURE 1-3 Licensed Drivers, Vehicle Registrations, and Resident Population: 1961–2013



NOTE: Shaded areas indicate economic recessions.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics* 2013. Tables DL-1C and MV-1. Available at http://www.fhwa.dot.gov/policyinformation/statistics/2013 as of June 2015.

There is no organized database on the operating condition of vehicles traveling on the Nation's highways. Box 1-B shows that the average age of the light-duty vehicle fleet increased by 28 percent over the 2000 to 2013 period and stood at about 11.4 years in 2013. The commercial truck fleet is even older. The average age of the commercial trucks is now 14.7 years, up from 12.5 years in 2007 [IHS 2015].[7] However, age cannot be used to gauge vehicle condition. Many older vehicles that have been well maintained continue to be in sound condition, while poorly made or maintained newer vehicles may be in poor operating condition.

[7] IHS Automotive acquired R.L. Polk & Co. in 2013 and continues the former Polk automotive registrations proprietary data series.

Traffic Control Systems

Traffic control features, such as traffic signs, signals, and pavement markings, are an important element of the highway system, but there is no national database on traffic control systems and their condition. An estimated 311,000 traffic signals have been installed in the United States, with an aggregate public capital investment of $83 billion [NTOC 2012]. There are no comparable estimates of the numbers of other types of traffic control devices.

Public Transit

Public transit provided 10.4 billion unlinked trips in 2013, up by 1.7 billion (19.4 percent) over the 2000 total. Over 850 urban transit agencies and more than 1,700 rural and tribal government transit agencies offer a range of travel options, including commuter, transit, and trolley bus; subway and light rail; and ferryboat. Buses accounted for nearly half (about 49.2 percent) of the 137,000 transit vehicles in 2013 (box 1-A). In 2013 these transit agencies operated over 5,000 stations, 79 percent of which comply with the *Americans with Disabilities Act* (Pub. L. 101-336), and 1,700 maintenance facilities. Transit agencies vary widely in size, ranging from 1 to 12,500 vehicles (e.g., the New York City Metropolitan Transportation Authority) [USDOT FTA NTD 2014]. Box 1-C shows U.S. cities with bike-share systems, which often extend the reach of existing public transit systems (bus, ferry, and rail).

The average age of transit vehicles over the 2000 to 2013 period is shown in box 1-B. Commuter rail passenger coaches aged the most among rail vehicles over that period and are among the oldest of all transit equipment. The heavy-rail car fleet age decreased by 2.7 years between 2000 and 2013, but was still 20.2 years old on average. Light-rail vehicles maintained an average age of about 16 years and transit buses 8 years over the reporting period, indicating that many transit agencies retired and replaced older vehicles on a regular basis. As would be expected, the transit bus fleet remained considerably newer than the rail fleet, which has locomotives and cars that typically last for decades. The average age of ferry boats dropped by 4.2 years, but they remained the oldest part of the transit vehicle population.

There appears to be a direct relationship between public transit system condition and performance and transit ridership (see e.g., Grava 2002 for detailed discussions of the ridership history of each transit mode). Deferred maintenance, outdated equipment and passenger stations, and numerous stops produce an overall transit image that may discourage prospective riders. Conversely, modern, well designed and maintained systems might attract riders who would otherwise travel by other means.

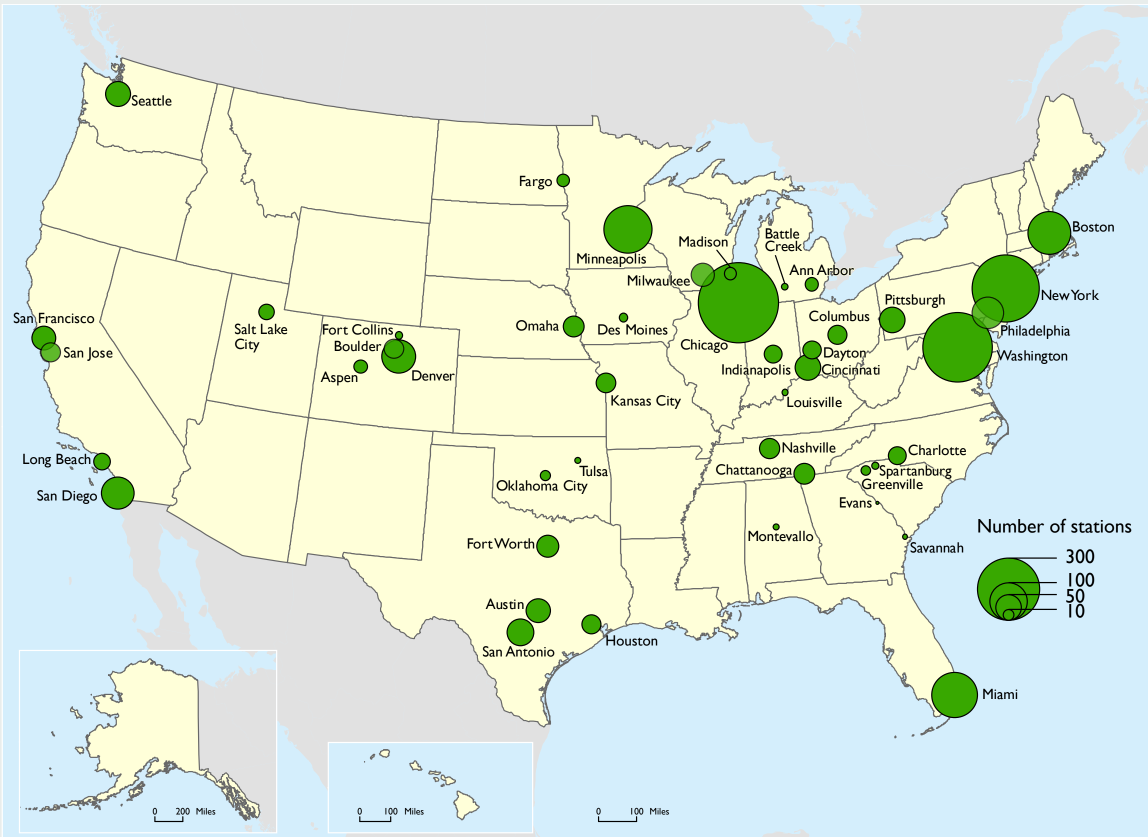
According to USDOT's biennial conditions and performance report, the current total investment across all transit systems is $16.5 billion annually. Bringing all systems to a state of good repair would require an increase to $18.5 billion per year. However, increasing system capacity to accommodate higher transit ridership would require an estimated $22.0 billion to support a 1.4 percent annual ridership growth rate versus an estimated $24.5 billion to support a 2.2 percent annual ridership growth rate [USDOT FHWA and FTA 2013].

Aviation

The main elements of the aviation system include airport runways and terminals, aircraft, and air traffic control systems. Box 1-A shows that in 2013 the United States had about 19,500 airports ranging from rural grass landing strips to urban rooftop heliports to large, paved, multiple-runway airports. Many commercial airports now serve aircraft that are larger than those serviced a decade ago as airlines seek to maximize profits by increasing capacity and seating more passengers. The passenger load factor—an indicator of capacity utilization—for U.S. airlines grew from 73.6 percent in 2003 to 82.7 percent in 2014 [USDOT BTS OAI 2015]. Most of the nearly 5,200 public-use facilities are general aviation airports, serving a wide range of users. In addition,

BOX 1-C U.S. Cities with Bike-Share Systems

As of August 2015, there are a total of 2,666 bike-share stations in 68 cities (shown in the map below). Six of these cities operate more than 100 stations: Washington, DC; Chicago; Boston; New York; Minneapolis; and Fort Lauderdale, Lauderdale by the Sea, and Pompano Beach.



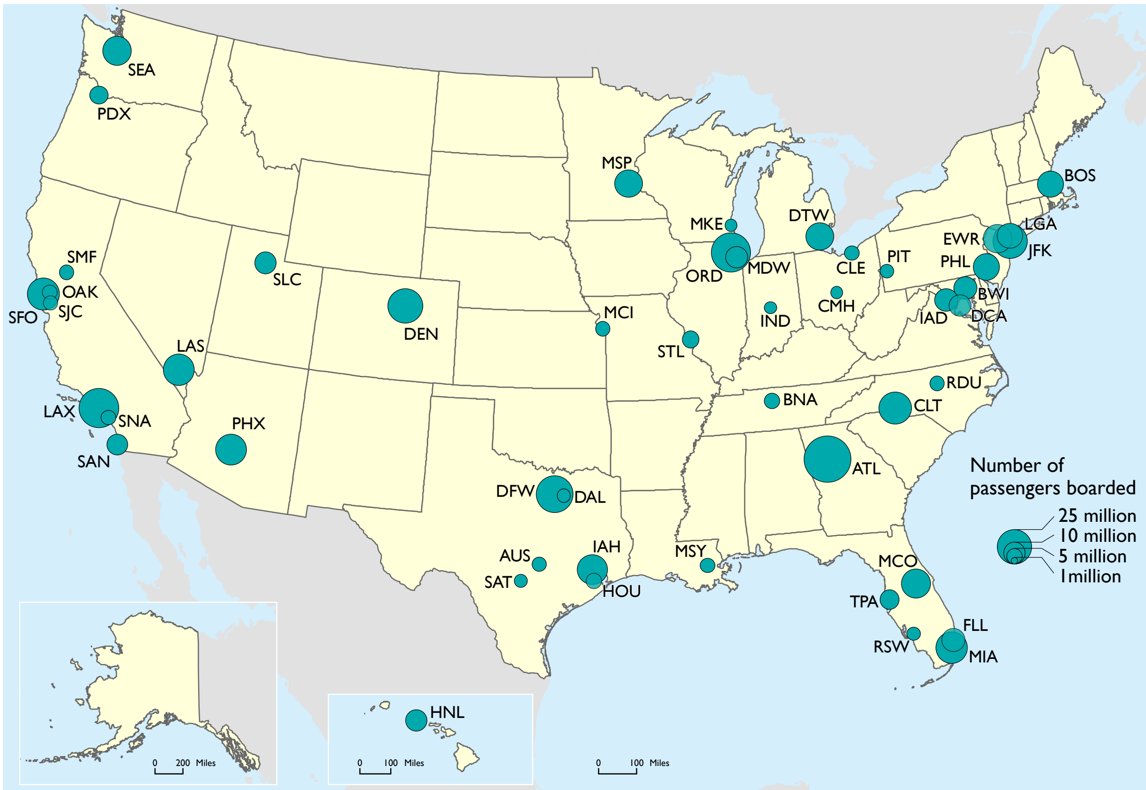
SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, *Intermodal Passenger Connectivity Database*, Available at http://www.bts.gov as of November 2015.

there are about 14,000 private airports, which are relatively small. Figure 1-4 shows the passenger boardings at the top 50 airports in 2014. These airports account for 83.4 percent (about 597 million) of the U.S. passenger enplanements on all domestic flights in 2014 [USDOT BTS OAI 2015].

The Federal Aviation Administration (FAA) compiles data on runway pavement conditions, which are presented in box 1-B. Most airport pavements (commercial service, reliever, and select general aviation) were in good condition between 2000 and 2013, with only 2 percent rated as poor. There are no similar data for other elements of aviation infrastructure.

Box 1-B shows average ages of U.S. commercial aircraft in 2010 and 2013. The aircraft flown by the major national airlines are roughly half the age of the smaller planes used by regional airlines. There are no public

FIGURE 1-4 Passengers Boarded at Top 50 U.S. Airports: 2014



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Office of Airline Information, *T-100 Market Data*, available at www.transtats.bts.gov as of April 2015.

data other than age to indicate the physical condition of the aircraft fleet.

The FAA is in the midst of a major effort to upgrade the U.S. air traffic control (ATC) system to increase its capacity. Current efforts are focused on developing the Next Generation Air Transportation System (NextGen), which will utilize GPS satellite technology and related communications and information technology improvements. A major reason for this effort is that the ATC system relies on ground-based radar and voice communication technologies, some of which date back to the 1940s, limiting its ability to increase capacity in line with increasing air traffic demand.

The Airports Council International (ACI) surveyed its U.S. members to ascertain their capital project needs for the 2013 to 2018 period. The survey indicated a total need of $75.7 billion. Age and technological obsolescence are likely the drivers for much of this need, as many airports were built more than 40 years ago. Increasing traffic demand as the U.S. economy has improved, and airline consolidation and increased concentration on hub airports, are cited as other factors.

Large hub airports account for 53 percent of projected investment needs, while medium and small hubs make up another 22 percent. Overall, 48 percent of the funding would be for terminal improvements, and 26.5 percent would be spent on runways, taxiways, and aprons [ACI 2015].

Railroads

The United States had almost 140,000 railroad route-miles in 2013 [AAR 2015], including about 95,200 miles owned and operated by the seven Class I railroads.[8] Amtrak, local, and regional railroads operated the remaining 44,000 miles. Class I railroads owned and operated over 25,000 locomotives and 373,800 freight railcars.

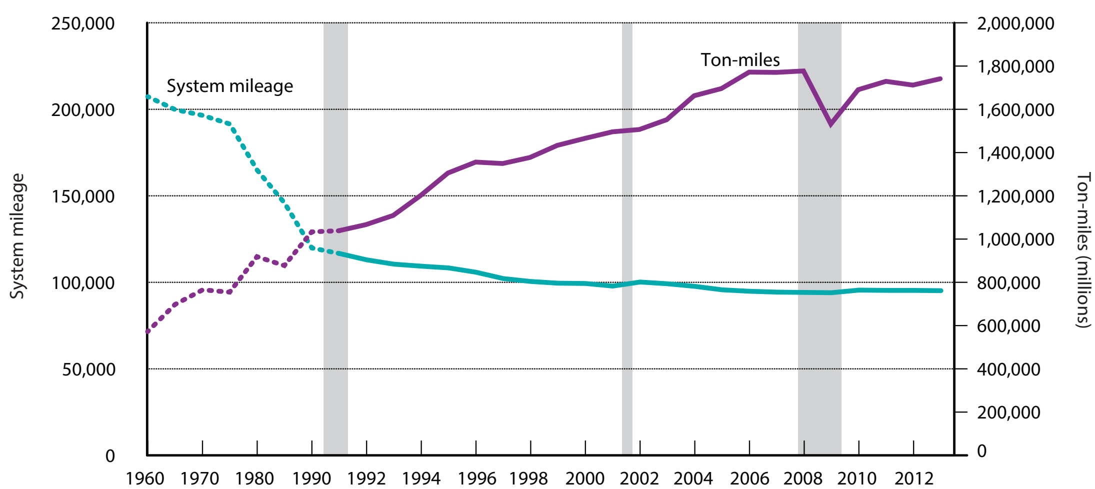
[8] Includes BNSF Railway, CSX Transportation, Grand Trunk Corp., Kansas City Southern, Norfolk Southern, Soo Line (Canadian Pacific operations in the United States), and Union Pacific.

Over the past 50 years, Class I railroads and connecting facilities have developed increasingly efficient ways to carry and transfer cargo (e.g., double-stack container railcars and on-dock rail), allowing more cargo to be carried with fewer railcars. Figure 1-5 shows that the system mileage of Class I railroads in 2013 was less than one-half the mileage in 1960. However, freight rail ton-miles nearly tripled to 1.7 trillion during the same period (despite a decline during the last recession).

Intercity Passenger Rail

The National Rail Passenger Corp. (Amtrak) is the primary operator of intercity passenger rail service in the United States. Amtrak operated 21,300 route miles in 2013 and more than 500 stations that served 46 states and Washington, DC. Figure 1-6a shows the top 25 stations by ridership across the country, and figure 1-6b shows the stations by ridership

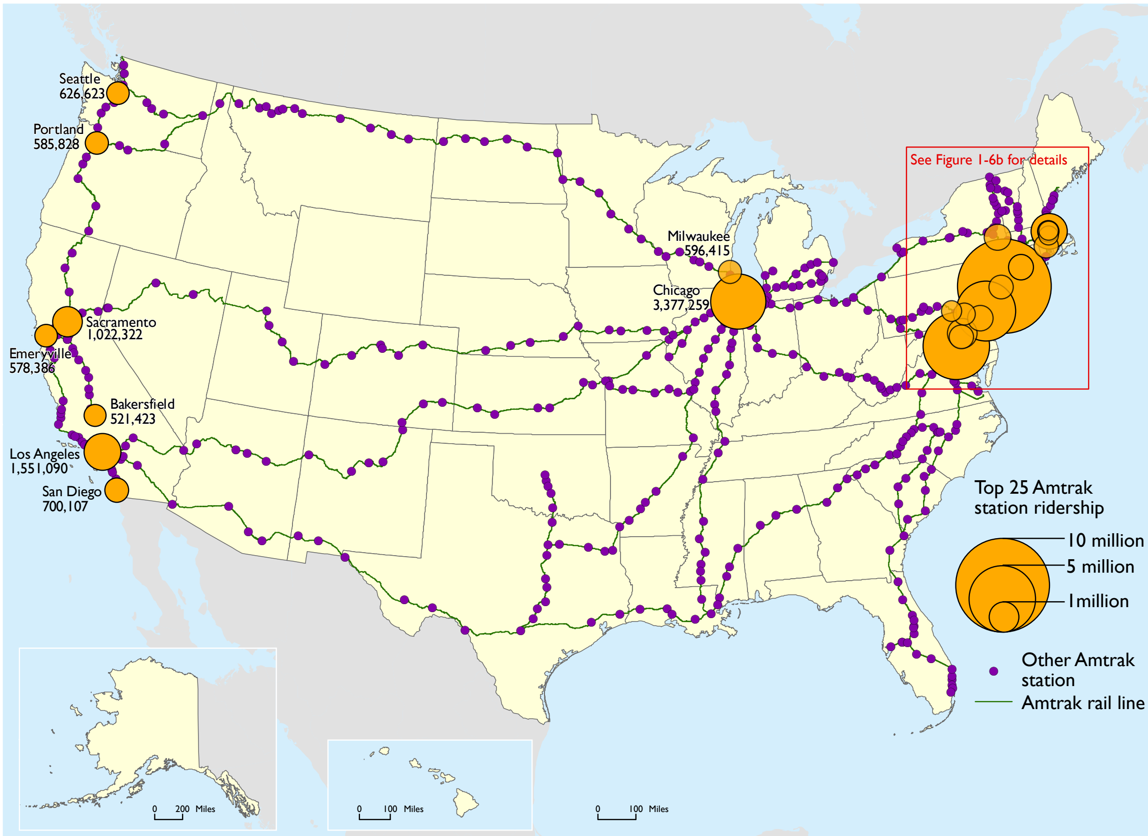
FIGURE 1-5 Class I Railroad System Mileage and Ton-miles of Freight:1960, 1965, 1970–2013



NOTE: Shaded areas indicate economic recessions.

SOURCE: Association of American Railroads, *Railroad Facts*, Statistical Highlights (Washington, DC: Annual Issues).

FIGURE 1-6a Top 25 Busiest Amtrak Stations: 2014



SOURCE: National Rail Passenger Corporation (AMTRAK), *National Fact Sheet* (January 2014). Available at http://www.amtrak.com as of March 2015.

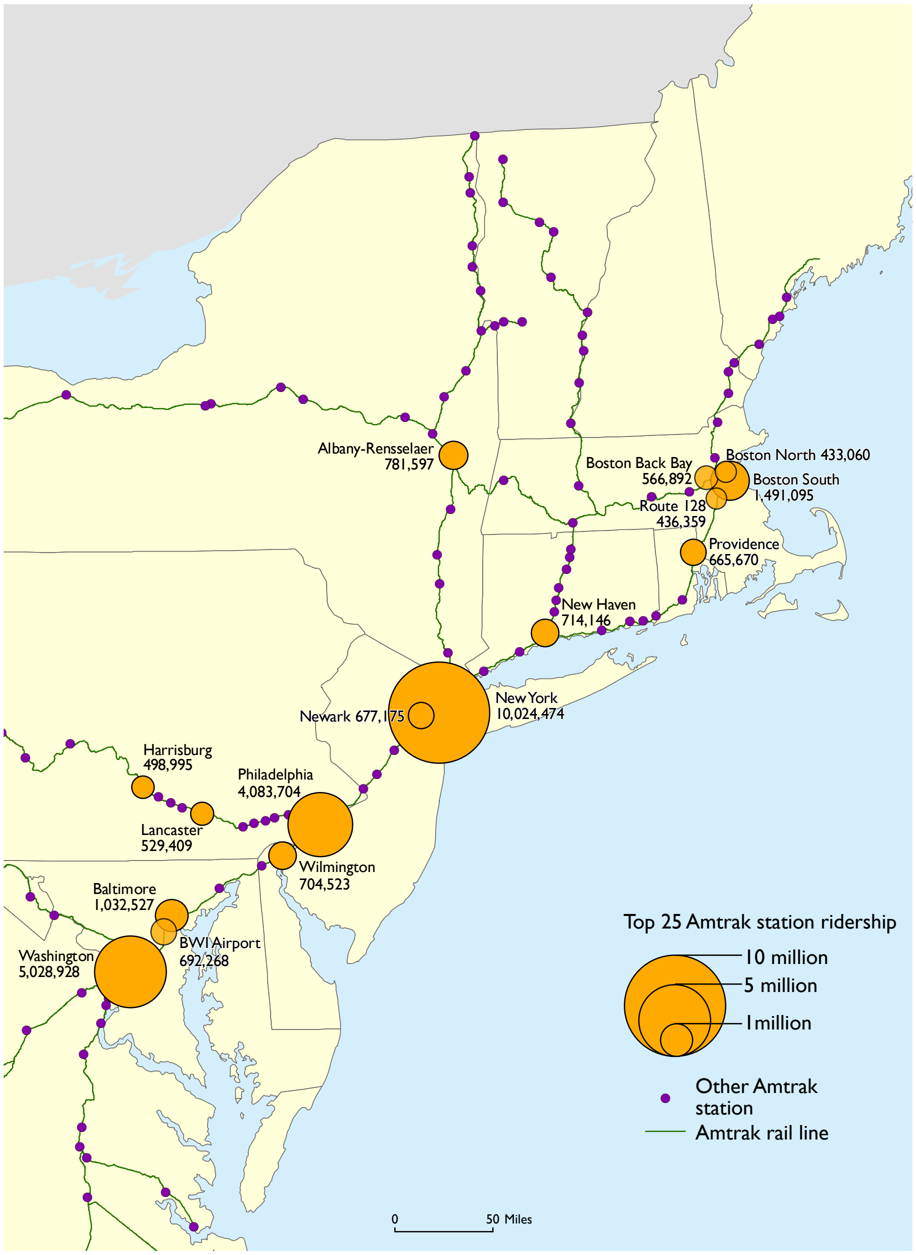
in the Northeast Corridor (NEC). Ridership was also high around Chicago as well as at several locations in California and the Pacific Northwest.

Amtrak owns a small fraction of its route miles, primarily 363 of the 456-mile NEC between Boston, MA, and Washington, DC, plus three other shorter segments totaling 261 miles [AMTRAK 2014]. The vast majority of passenger train services outside the NEC are provided over tracks owned by and shared with the Class I freight railroads. Hence, the condition of the infrastructure Amtrak uses is largely dependent on the condition of the host railroads, with the exception of the NEC.

Freight Rail

The U.S. freight rail system is privately owned and operated, and rail carriers are under no obligation to report freight track conditions to public sector agencies. Thus universal track condition reports are unavailable. Railroads are responsible for ensuring track safety, and to that end they regularly inspect their track and perform necessary repairs. The Federal Railroad Administration (FRA) regulations

FIGURE 1-6b Amtrak Stations and Ridership along the Northeast Corridor: 2014



SOURCE: National Rail Passenger Corporation (AMTRAK), *National Fact Sheet* (January 2014). Available at http://www.amtrak.com as of March 2015.

require railroads to maintain track inspection records and make them available to FRA or State inspectors on request. The FRA's rail safety audits focus on regulatory compliance and prevention and correction of track defects. Presently, there is no regular program for assembling and analyzing the many thousands of inspection reports that are prepared each year.

There is, however, one FRA program that generates systematic data on track condition. The Automated Track Inspection Program (ATIP) utilizes a small fleet of highly instrumented track geometry inspection cars to survey tens of thousands of miles of high traffic density and other high priority routes each year. Table 1-2 provides a summary of track inspection results for the years 2004 to 2014. Of the eight track inspection exceptions that are monitored, the incidences of gauge and limited speed have dropped in recent years. The FRA implemented upgrades to the inspection and collection technology in the ATIP fleet in 2013, which allowed for increased sensitivity of exception detection. Inspection locations vary by year due to the limited number of surveying cars and are prioritized by factors such as safety risk analysis and operation types.

The installation of new rail and crossties is one indicator of how track conditions are maintained and improved. The Association of American Railroads (AAR) reported that the Class I railroads installed nearly 620 thousand tons of rail and 16.2 million crossties in 2013, which is more than the annual average of 546 thousand tons of rail and 13.4 million crossties from 2001 to 2005 [AAR 2014].

The AAR also provides data on the age of the seven Class I railroad locomotive fleets (box 1-B). The fleet has become considerably newer since 2000. The percentage of locomotives that were less than 10 years old increased from 36.5 percent in 2000 to 45.2 percent in 2010, and their median age dropped from about 18 to 13 years. The pace of fleet renewal slackened a bit from 2010 to 2013 as the median age increased to about 16 years. No comparable compilation of the age distribution of railcars is available.

Box 1-B shows railroad capital expenditures, which totaled $13.1 billion in 2013, more than doubling the spending in 2000. In contrast, revenue ton-miles increased 18.7 percent over that period [AAR 2014]. Freight rail is a profit-making enterprise that self-funds its investments, and carriers have a strong incentive to maintain, rehabilitate, and upgrade their systems as needed to remain competitive in the market place and earn returns for their investors.

Ports and Waterways

More than 8,200 U.S. water transportation facilities, including cargo handling docks, handled 3.2 billion short tons of goods in 2013. Of these facilities, 2,000 handled both foreign and domestic cargo, less than 80 handled foreign cargo only, and nearly 6,100 handled domestic cargo only. About 69 percent of cargo-handling facilities are located on the coasts—Gulf coast facilities accounted for 26.2 percent of the total, followed by the Atlantic coast (21.8 percent), and the Pacific coast (20.6 percent). The remaining 31.4 percent of cargo-handling facilities are situated along the Great Lakes or inland waterways. These facilities are served

TABLE 1-2 Automated Track Inspection Program (ATIP) Exceptions[1] per 100 Miles: 2004–2014

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Profile	4.2	3.4	3.5	3.2	2.4	1.9	2.1	2.4	1.4	17.4	9.9
Alignment	2.7	1.6	1.3	1.7	1.4	1.8	2.0	2.0	1.5	18.4	10.6
Gage	13.6	8.5	6.6	5.1	12.2	7.2	3.1	2.1	4.4	5.9	2.1
Crosslevel	8.7	5.2	5.6	2.0	2.0	2.2	1.2	1.3	1.1	6.9	4.0
Warp	8.1	11.2	6.7	4.7	3.7	4.0	2.8	1.8	1.7	10.9	4.6
Runoff	0.1	0.8	0.7	0.4	0.6	0.7	0.6	0.8	0.4	10.0	8.4
Twist	0.6	5.5	1.9	1.8	1.7	1.5	1.3	1.0	0.8	5.6	3.0
Limited speed	6.8	6.3	5.9	9.9	9.7	8.7	11.8	3.1	2.6	2.5	1.4
Total per 100 miles	**38.0**	**36.1**	**26.3**	**28.7**	**33.7**	**27.9**	**24.8**	**14.5**	**14.1**	**77.6**	**44.0**
Miles	34,699	29,051	26,886	59,165	52,997	74,715	83,013	74,541	70,049	62,882	74,202

[1] *Exceptions* mean track did not meet normal operation standards.

KEY: ATIP = Automated Track Inspection Program.

NOTES: The ATIP program does not provide a comprehensive evaluation of the national rail network on an annual basis due to the limited number of surveying cars. Inspection locations vary by year and are prioritized by factors such as safety risk analysis and operation types. The FRA implemented upgrades to the inspection and collection technology in the ATIP fleet in 2013 which allowed for increased sensitivity of exception detection. Multiple cars surveying except for 2005. Defects are briefly defined as variations from design values for the following track geometry properties:

Profile - rail surface elevations
Alignment - track direction (tangent or curvature)
Gage - distance between rails
Cross-level - elevation difference between the rails
Warp - maximum change in cross-level over a specified distance
Runoff - elevation (ramp) difference of a line along the top of the rail is used for the projection
Twist - rate of introduction and removal of cross-level on transitions from straight to curved track alignment
Limited Speed - reduced operating speed due to track geometry constraints

Detailed definitions and standards may be found in U.S. Department of Transportation, Federal Railroad Administration, *Track and Rail and Infrastructure Integrity Compliance Manual*, July 2012.

SOURCE: U.S. Department of Transportation, Federal Railroad Administration, Office of Safety, *ATIP Statistics* (June 15, 2015). Available at http://www.fra.dot.gov/ as of July 2015.

by a fleet of 40,000 domestic vessels—31,000 barges and 9,000 self-propelled vessels, including almost 3,000 towboats used to move the barges [USACE IWR NDC 2015a].

Dams and navigation locks are two of the principal infrastructure features of the U.S. domestic waterway transportation system. They enable shallow draft operations on most rivers. The principal exceptions are the Lower Mississippi River and the Missouri River, which are free-flowing but still require some types of hydrologic structures, such as large rock and concrete groins and revetments, to manage the flow of the river and preserve navigation. The U.S. Army Corps of Engineers (USACE) owns and operates 239 lock chambers at 193 sites, which account for most of the U.S. inland navigation locks. The average age of all locks is over 62 years[9] (box 1-B). The USACE maintains comprehensive data on lock traffic, lockage time and delay, and lock outages for waterway performance analysis.

Table 1-3 provides data on representative locks throughout the inland waterway system. These

[9] A recent Transportation Research Board (TRB) report [TRB 2015] shows that, when adjusted for the dates of major rehabilitation projects, the effective average age of locks is about 10 years less, but that still puts the average age at over 50 years.

data show some of the relationships between lock age and performance factors, such as tow delay and lock chamber downtime. For example, the Emsworth Lock on the Ohio River is one of the oldest structures in the system and is considered functionally obsolete. It has lock chambers designed for vessels of an earlier era and has lengthy out-of-service delays. The newer locks on the Ohio River, such as John T. Myers, are larger and have relatively low average tow delays and only short-duration service outages. Lock 52 on the Ohio River is the busiest and also one of the oldest with chambers that are 45 and 86 years old, respectively. It had one of the highest average tow delays in the entire inland waterway system, 8.6 hours per tow in 2013.

On the Upper Mississippi River, the Melvin Price Lock has the two newest lock chambers listed in table 1-3. It passes over 40 million tons of freight per year with little delay or downtime. Just 15 miles downstream, Lock 27, with two identical size but much older chambers (61 years), has an average tow delay that exceeds 6 hours. The Inner Harbor Navigation Lock, in New Orleans, is one of the principal bottlenecks in the Gulf Intracoastal Waterway. The small chamber size of the 91-year-old lock results in an average tow delay of more than 12 hours.

Shallow and deep-draft ports and channels are other important infrastructure elements of the waterway system. There are several thousand inland river ports and terminals, the vast majority of which are privately owned and serve specific cargo-handling needs (e.g., coal loading and petrochemical transfers). Deep draft ports are large and capital-intensive

TABLE 1-3 Selected Inland Waterway Lock Characteristics: 2013

River	River Mile[a]	Lock Chamber Name	Length, feet	Width, feet	Age, years	Tons in 2013, million[b]	Avg. Delay per Tow, hr[b]	Outages in 2013[b]: Num.	Outages in 2013[b]: Hours	Outages in 2013[b]: Avg. hr. per outage
Ohio	6.2	Emsworth Lock & Dam Aux.	360	56	93					
Ohio	6.2	Emsworth Lock & Dam	600	110	93	19.6	3.02	54	1,048	19.41
Ohio	846	John T. Myers Lock & Dam Aux.	600	110	39					
Ohio	846	John T. Myers Lock & Dam	1,200	110	39	60.7	0.65	99	70	0.71
Ohio	938.9	Lock & Dam 52 Aux.	600	110	86					
Ohio	938.9	Lock & Dam 52	1,200	110	45	84.0	8.61	44	999	22.70
Mississippi	200.8	Melvin Price Lock & Dam Aux.	600	110	20					
Mississippi	200.8	Melvin Price Lock & Dam	1,200	110	24	40.1	0.99	6	14	2.33
Mississippi	185.5	Chain of Rocks L/D 27 Aux.	600	110	61					
Mississippi	185.5	Chain of Rocks L/D 27	1,200	110	61	49.8	6.24	4	73	18.25
GIWW East	7	Inner Harbor Navigation Canal Lock	640	75	91	15.7	12.42	29	93	3.21
Columbia	292	McNary Lock & Dam	675	86	61	6.1	0.17	0	0	N/A

[a] Miles from the 0.0 milepoint reference location, usually at the mouth of the river, except on the Ohio River where mile 0.0 is at the source of the river at Pittsburgh, PA.

[b] Includes all lock chambers at sites with more than one chamber.

KEY: Aux = Auxiliary; GIWW = Gulf Intracoastal Waterway; L/D = Lock & Dam; N/A = Not Applicable.

SOURCES: U.S. Army Corps of Engineers, Institute for Water Resources, Navigation Data Center, *Locks by Waterway, Tons Locked by Commodity Group, CY 1993 - 2013*. Available at http://www.navigationdatacenter.us/lpms/cy2013comweb.htm as of June 2015. U.S. Army Corps of Engineers, Institute for Water Resources, Navigation Data Center, *Locks by Waterway, Lock Usage, CY 1993 - 2013*. Available at http://www.navigationdatacenter.us/lpms/lock2013web.htm as of June 2015. U.S. Army Corps of Engineers, Institute for Water Resources, Navigation Data Center. *Locks by Waterway, Lock Unavailability, CY 1993 - 2013*. Available at http://www.navigationdatacenter.us/lpms/data/lock2013webunavail-021914.htm as of June 2015. U.S. Army Corps of Engineers, Institute for Water Resources, Navigation Data Center, *Lock Characteristics General Report*. Available at http://www.navigationdatacenter.us/lpms/pdf/lkgenrl.pdf as of June 2015.

facilities, typically with extensive docks, wharves, cranes, warehouses, and other cargo transfer equipment and intermodal connections that integrate ocean transport with inland connectors. Private terminal operators do not routinely release data publicly on the condition of their facilities. The USACE maintains an extensive database of marine terminals, both shallow draft and deep draft, but it is largely static and does not include condition or performance data items and summary tabulations.

Many of the coastal seaports are served by post-Panamax vessels[10] that continue to increase in size. Containerships calling at U.S. ports had an average capacity of 3,542 TEU in 2013 [USDOT MARAD 2015]. Today's largest containerships can carry upwards of 18,000 TEU. Larger vessels afford greater economies of scale and cost savings. However, they require investments in U.S. ports such as increasing bridge clearances, channel depths, landside access, and port and terminal infrastructure [USACE IWR 2012].

The main characteristic of navigation channels that relates to condition is whether the authorized depth is actually available. Nearly all channels need periodic dredging to maintain the authorized depth. Most channel dredging occurs under the auspices of the Army Corps of Engineers. In 2013 the Corps' and contractor's dredges removed 197 million cubic yards of material, down from 238 million in 2012. In 2013 maintenance dredging accounted for 84.3 percent of the removed material; the average cost per cubic yard increased 11.8 percent to $4.44 [USACE 2015a]. The Corps maintains detailed dredging data, but it does not produce summary tabulations that differentiate the work by deep or shallow draft channels.

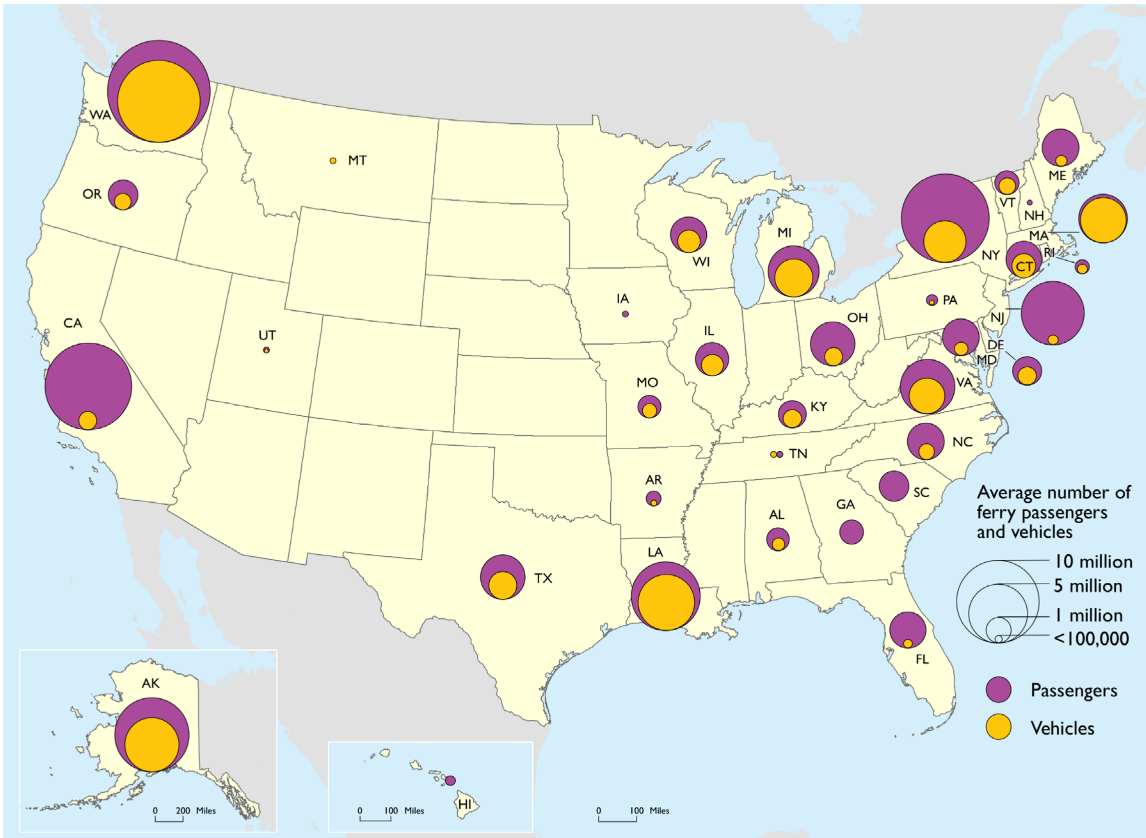
U.S. flag vessels operate on both shallow and deep draft waterways and numerous foreign flag vessels call at deep draft ports. Box 1-B provides age distributions of U.S. flag vessels for the 2000 to 2013 period. The fleet got a bit younger over that period. The percent of vessels younger than 16 years increased from 34 to 46 percent. Inland waterway towboats and barges account for the largest share (85 percent) of U.S. vessels. Towboats are the oldest vessels in this assemblage; 69 percent are older than 25 years [USACE 2015]. In contrast, barges are among the youngest vessels due to a combination of retirement and replacement of older dry cargo barges and acquisition of new tank barges. This is largely in response to the *Oil Pollution Act of 1990* (Pub. L. 101-380) that decreed tank barges and vessels must have double hulls by January 1, 2015.

U.S. ferries carried an estimated 103 million passengers and just over 37 million vehicles in 2009 [USDOT BTS 2014].[11] Figure 1-7 shows the average number of passengers and vehicles by state. In 2009, 218 ferry operators worked in 37 states, 10 in U.S. territories and 3 between U.S. and non-U.S. locations (e.g., Canada). The U.S. ferry fleet

[10] Vessels exceeding the length and width of the lock chambers in the Panama Canal. The Canal expansion project is scheduled to be completed in 2016, so vessels that exceed its new larger lock chamber size are referred to as "new Panamax."

[11] These data will be updated in the 2014 National Census of Ferry Operators, which is undergoing imputation.

FIGURE 1-7 Average Number of Ferry Passengers and Vehicles: 2009



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, *National Census of Ferry Operators 2010*, Available at http://www.bts.gov as of January 2014.

was composed of 652 vessels, 622 of which were in active service. California had the most ferry vessels with 62, followed by New York (56), Massachusetts (52), and Washington State (46). Nearly all of the vessels carried passengers (93.4 percent), while less than half (43.6 percent) carried vehicles, and less than a quarter carried freight (22.2 percent).

While there is no definitive list of waterway transportation system investment needs, several recent studies have made estimates. Based on the fact that navigation projects account for one-third of the Corps' 2012 budget, the American Association of State Highway and Transportation Officials (AASHTO) estimated the agency's navigation project backlog totaled $20 billion [AASHTO 2013].

Pipelines

Natural gas was transported via about 320,000 miles of natural gas transmission pipeline and over 2.1 million miles of natural gas distribution main and service pipelines in 2013 (box 1-A). These pipelines connect to 65 million households and 5 million commercial businesses, and to the 1,900 electrical generating units that supply approximately 25 percent of U.S. electricity [AGA 2015]. Over 192,000 miles of crude/refined oil and hazardous liquid pipelines carried over 2.2 billion barrels across the United States [USDOE EIA 2015b].

The Pipeline and Hazardous Materials Safety Administration (PHMSA) collects annual report data from pipeline operators, covering their system mileage, commodities transported, and inspection activities, but there is no publicly available database that tracks pipeline condition. A serious failure, such as the Santa Barbara, CA, crude petroleum pipeline failure in May 2014, serves as a reminder that this part of the transportation system has the same problems with aging infrastructure as the other modes profiled in this chapter [USDOT PHMSA 2015].

As with railroads, pipeline companies are private enterprises that are responsible for their own system maintenance, rehabilitation, and expansion. Hence, there are little data or estimates available on systemwide capital investments.

Challenges

With the largest transportation system in the world, the United States faces a continuing challenge of maintaining system conditions in sufficiently good shape to meet the enormous mobility requirements of the American economy and society. As indicated earlier, the condition of transportation infrastructure is improving, but additional improvements are needed. The average age of all inland waterway navigation locks is more than 50 years, and 11 percent of highway bridges are considered structurally deficient. If these condition issues are not addressed, they could affect system performance in the coming years.

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