7.0 Crude Oil and Ethanol Transportation and Trends

7.1 Economic and Geographic History and Trends for Rail Transportation of Oil and Ethanol

7.1.1 Crude Oil Rail Transportation

U.S. crude oil production numbers continue to climb with the advent of the Shale Revolution, which has been attributed to technological advances that has made it easier [and more economically feasible] to extract oil and natural gas from permeable shale rock. With the new geologic discoveries, pipelines infrastructure is not present in these locations. New pipeline construction lags behind the crude oil production, so existing railroad systems are being used to move the commodity. According to Association of American Railroads (AAR), U.S. Class I railroads originated 9,500 carloads of crude oil, in 2008.[38] In 2014, they originated 493,146 carloads, an increase of nearly 5,100 percent over a six-year period.

7.1.2 Economic Benefits from Crude by Rail Transportation

Growth in domestic crude oil production is important in the U.S. goal to become more energy independent [from traditional oil-supplying countries]. Crude oil needs to be refined in order to increase its value. It is worth noting that existing pipeline networks are not able to handle the added volume from the Shale Revolution, combined with the fact that most refineries exist in traditional crude oil areas [the South and the coasts]; the railroad network makes it possible to transport the raw material efficiently and effectively.

According to AAR, some economic benefits associated with continued growth in domestic crude oil production are:[39]

- Reductions in the U.S. trade deficit of tens of billions of dollars every year
- New and better employment and economic development opportunities for communities all over the country
- Billions of dollars in new tax revenues
- Reduced reliance on oil from sources in the world that are not secure and whose interests do not necessarily correspond well to those of the United States
- Reduced vulnerability to oil shocks that in the past have caused immense harm to the U.S. economy

By using an underlying infrastructure, transporting crude by rail enables producers to use a carrier who can move their product to any refinery terminal, while also being responsive to changing economic conditions [growth and decline of crude oil demand]. These competitive advantages [for producers and railroads] make it easy to see why crude oil rail transportation is so widespread in the U.S.

[38] Association of American Railroads, *US Rail Crude Oil Traffic*, https://www.aar.org/BackgroundPapers/US%20Rail%20Crude%20Oil%20Traffic.pdf
[39] Ibid.

7.1.3 Ethanol Rail Transportation

Since 2000, U.S. ethanol production has grown sharply from 1.6 billion gallons (2000) to 14.3 billion gallons (2014), a 780 percent increase. Ethanol production is concentrated in the Midwest and Great Plains, where a majority of the raw material, needed for production, is grown. With railroad networks all over the U.S., freight railroads play a major part in the movement of ethanol. According to AAR, all Class I railroads transport ethanol. It is estimated that 15 percent to 20 percent of ethanol movements occur via Class II and Class III railroads.[40]

Due to ethanol's corrosive and miscible properties, piping ethanol over long distances is somewhat risky. Instead, rail transportation of ethanol is safer, more flexible, and is more efficient. As a suitable transportation alternative, ethanol by rail movements account for around 70 percent of total ethanol transport.

7.1.4 Economic Benefits from Ethanol Transportation

Ethanol is being produced all across the U.S., with the highest concentrations for production centralized in the Midwest and Great Plains. Harvested plants are one of the major ingredients in ethanol; this raw material is abundant and within close proximity to grain elevators and railroad networks, which allows it to be easily transported to biorefineries for processing.

The prevalent method for producing ethanol is wet milling, where the grain [mostly corn] is soaked in water and strong acid. This method separates the grain into many useable components, such as starch, gluten, fiber, and germ. All of these components are further processed to create [corn] oil, gluten meal, starches, [corn] syrup, and through an added process of fermentation – ethanol. The sheer act of creating ethanol spins off many other industries, not to mention the waste product from ethanol production is often used as cattle feed.

Ethanol has changed the energy landscape, and is used in over 97 percent of U.S. gasoline and makes up over 10 percent of the gasoline supply.[41] This commodity is helping to drive energy independence from oil producing countries, as well as supporting American jobs. Per AAR, ethanol accounted for 1.0 percent of total rail carloads and 1.5 percent of rail tonnage, in 2012 - the highest volume chemical commodity.

7.2 Current Locations of Ethanol and Crude Oil Producing Points and Destination Points

The majority of crude oil being produced is coming from formations in Canada, the Upper Plains, the Rocky Mountains, and Southwest. Generally, crude-by-rail is moving toward oil refineries near the Gulf, Atlantic, and Pacific Coasts. See Figure 3, Crude-by-Rail Movements for general crude oil trends.

This section summarizes the key issues affecting the rail transportation of crude oil and ethanol in Iowa. Included are the location of Iowa's biorefineries and rail networks carrying crude oil and ethanol, federal rules and regulations for rail equipment used to transport hazardous

[40] Association of American Railroads, *Railroads and Ethanol*,https://www.aar.org/_layouts/15/download.aspx?SourceUrl=/BackgroundPapers/Railroads%20and%20Ethanol.pdf

[41] Renewable Fuels Association, *Why is Ethanol Important*, http://www.ethanolrfa.org/consumers/why-is-ethanol-important/

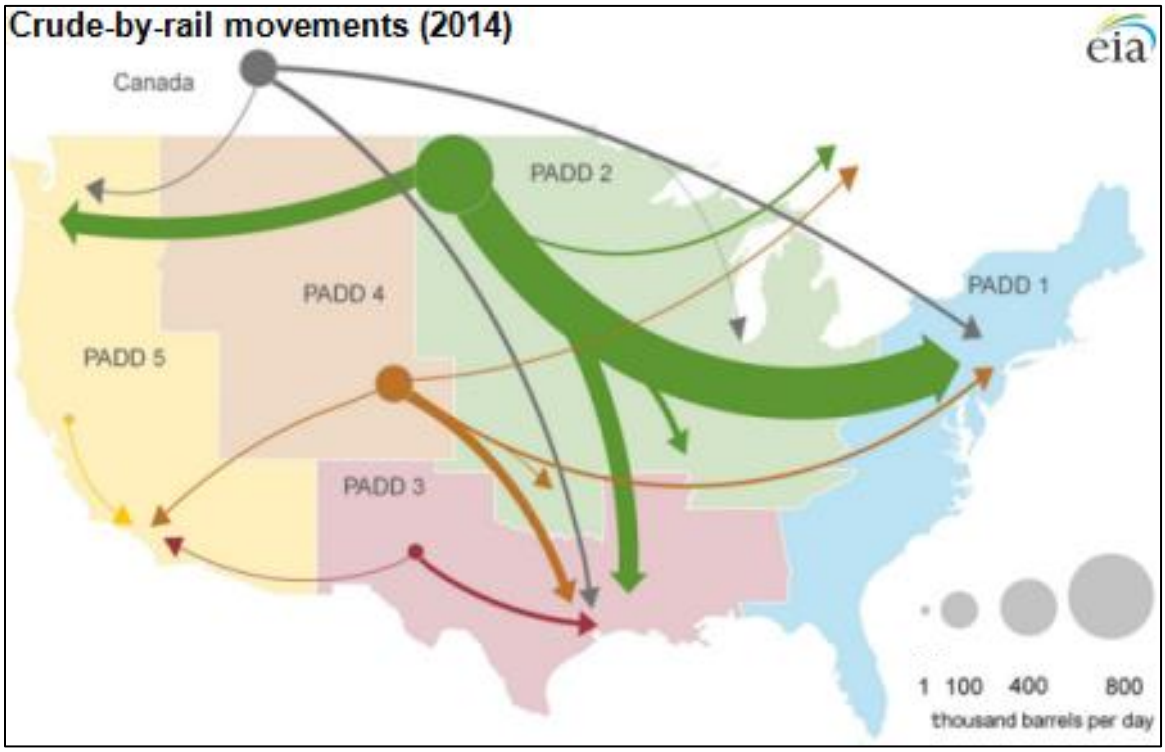
materials and for rail haulage of crude oil and ethanol, and results of coordination with federal and state agencies conducted during the Study. Railroad safety technologies are briefly described as they affect the analysis in this memorandum.

7.3 Potential Current and Likely Future Crude Oil Rail Routes and Ethanol Rail Networks in Iowa

To understand how Iowa's rail network is utilized in transporting crude oil and ethanol by rail, a holistic view of the commodities must be examined. First, the majority of North American crude oil production that is moved by rail or has the potential to move by rail is occurring at formations located in Western Canada, the Upper Great Plains, the Rocky Mountains, and west Texas, with the Upper Great Plains (principally western North Dakota) recently becoming a major new source for oil production. Growth in the Upper Great Plains has exceeded pipeline capacity, requiring shipment by rail.[42] As of September 2015, 49 percent of North Dakota Oil Production was shipped by rail, a total of 17.1 million barrels or approximately 220 trainloads.[43]

These crude-by-rail movements trend towards existing oil refineries located on or near the Gulf, Atlantic, and Pacific Coasts, the location of most refining capacity in the U.S. See below for Figure 3, Crude-by-Rail Movements for general crude oil transportation trends from producing locations to refining locations.

Figure 3. Crude-by-Rail Movements



Source: U.S. Department of Energy/Energy Information Administration (2014)

[42] U.S. Energy Information Administration, *Rail Deliveries of U.S. Oil Continue to Increase in 2014*, https://www.eia.gov/todayinenergy/detail.cfm?id=17751

[43] North Dakota Pipeline Administration, *Monthly Update – September 2015 Oil Production and Transportation*, https://ndpipelines.files.wordpress.com/2012/04/ndpa-monthly-update-november-13-20151.pdf

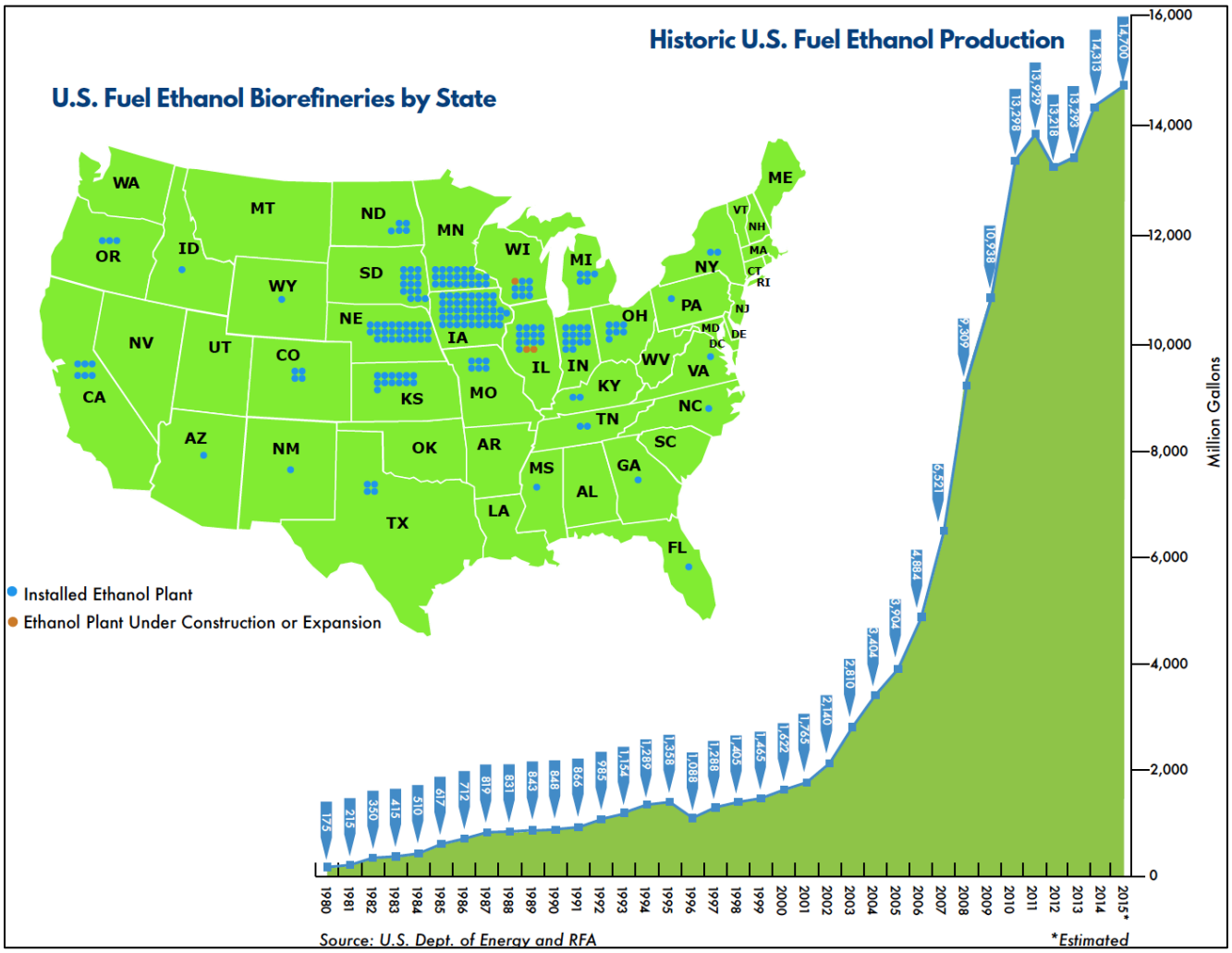
"The Petroleum Administration for Defense Districts (PADDs) are geographic aggregations of the 50 States and the District of Columbia into five districts"; Iowa falls into PADD 2 corresponding to the Midwest.[44] The PADDs help users of EIA's petroleum data assess regional petroleum product supplies and analyze patterns of crude oil and petroleum product movements moving throughout the country.[45]

Oil refineries convert the crude oil to usable forms, such as varying types of fuels (e.g., diesel, gasoline, jet fuel, etc.) and components for other petrochemical products. Refineries then distribute the final products to different markets. It is important to note that Iowa does not have any crude oil shipping or receiving facilities for crude oil unit trains, nor any refineries, so all of the rail traffic for this commodity moves through the state.

With its location centered in the middle of the U.S. "Corn Belt," the State of Iowa has more ethanol biorefineries than any other state in the country, and is the leader in ethanol production. Overall, 44 ethanol biorefineries are located within the state, leading Iowa to produce billion gallons of ethanol each year (Iowa accounts for approximately 26 percent of all annual U.S. ethanol production, in 2015).[46] See Figure 4, U.S. Ethanol Biorefineries by State and Historic U.S. Fuel Ethanol Production for ethanol production volumes and relative locations.

[44] U.S. Energy Information Administration, *PADD Regions Enable Regional Analysis of Petroleum Product Supply and Movements*, https://www.eia.gov/todayinenergy/detail.cfm?id=4890
[45] Ibid.
[46] Renewable Fuels Association, *Where Ethanol is Made*, http://www.ethanolrfa.org/consumers/where-is-ethanol-made/

Figure 4. U.S. Ethanol Biorefineries by State and Historic U.S. Fuel Ethanol Production (2015)



Source: U.S. Department of Energy/ Energy Information Administration and Renewable Fuels Association (2015)

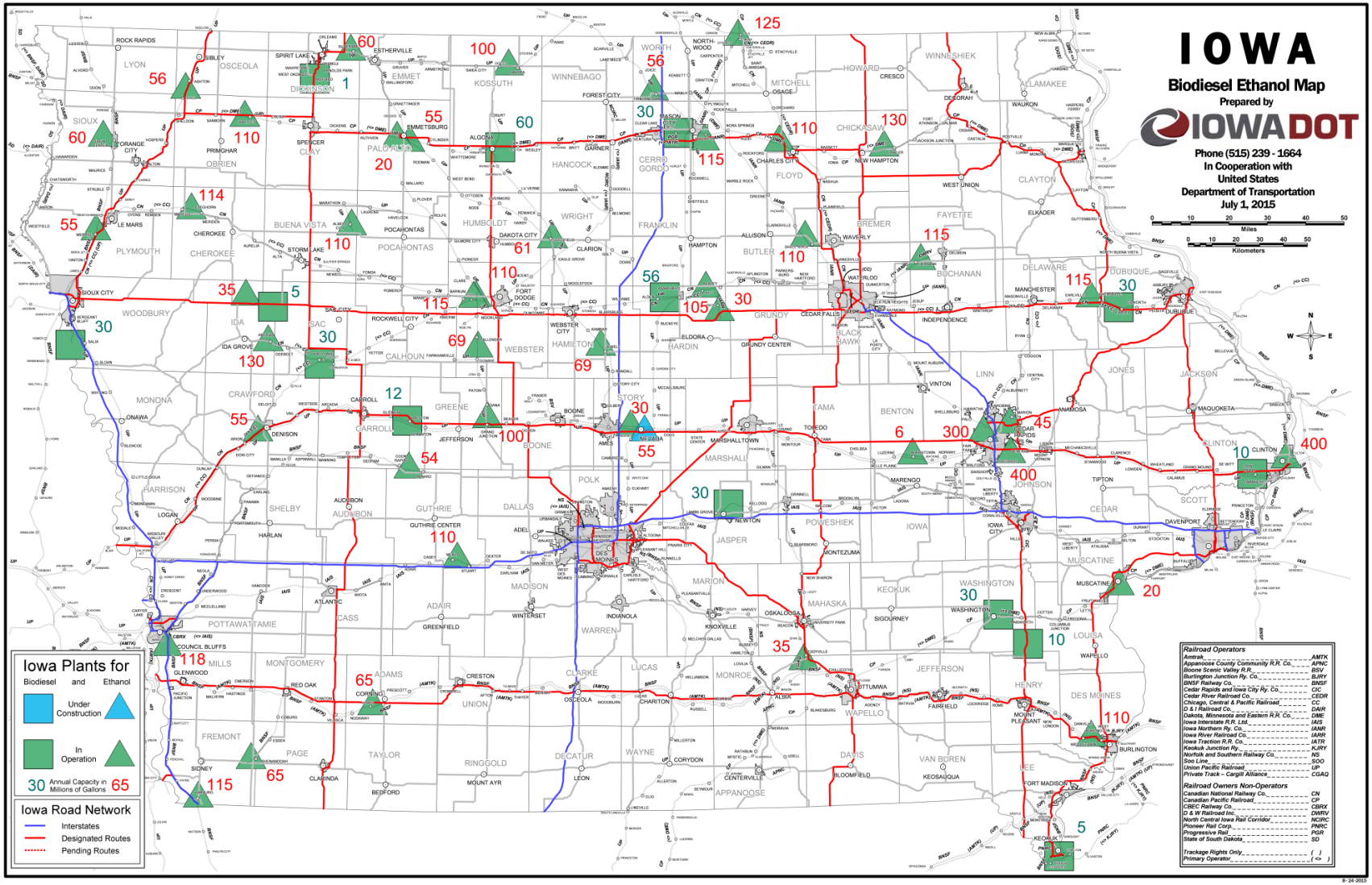
Similar to most other commodities, market forces determine ethanol consumption locations, transportation routes, and transportation volumes. Ethanol produced in Iowa that is consumed in local markets is typically trucked to blending terminals that serve consumption markets. Because surrounding states of Minnesota, South Dakota, and Illinois are also significant ethanol producers, ethanol produced in Iowa typically flows west, south, or east, as markets to the north of Iowa are supplied by ethanol producers closer to those markets. A substantial percentage of Iowa ethanol production is shipped by rail to blending terminals and oil refineries throughout the U.S. (with the exception to a large degree of ethanol producing states adjacent to Iowa). These blending terminals or refineries blend the ethanol with gasoline to meet air emissions regulations, and regional, market, and climate requirements.[47]

Since Iowa produces a surplus of ethanol, it must be exported to other states. Iowa's ethanol refinery locations are shown in Figure 5, Iowa Biodiesel Ethanol Map. Iowa's railroads typically

[47] Cummings, A. Trains. "*Ethanol: rail boom or bust*." August 2007. Pages 30-37.

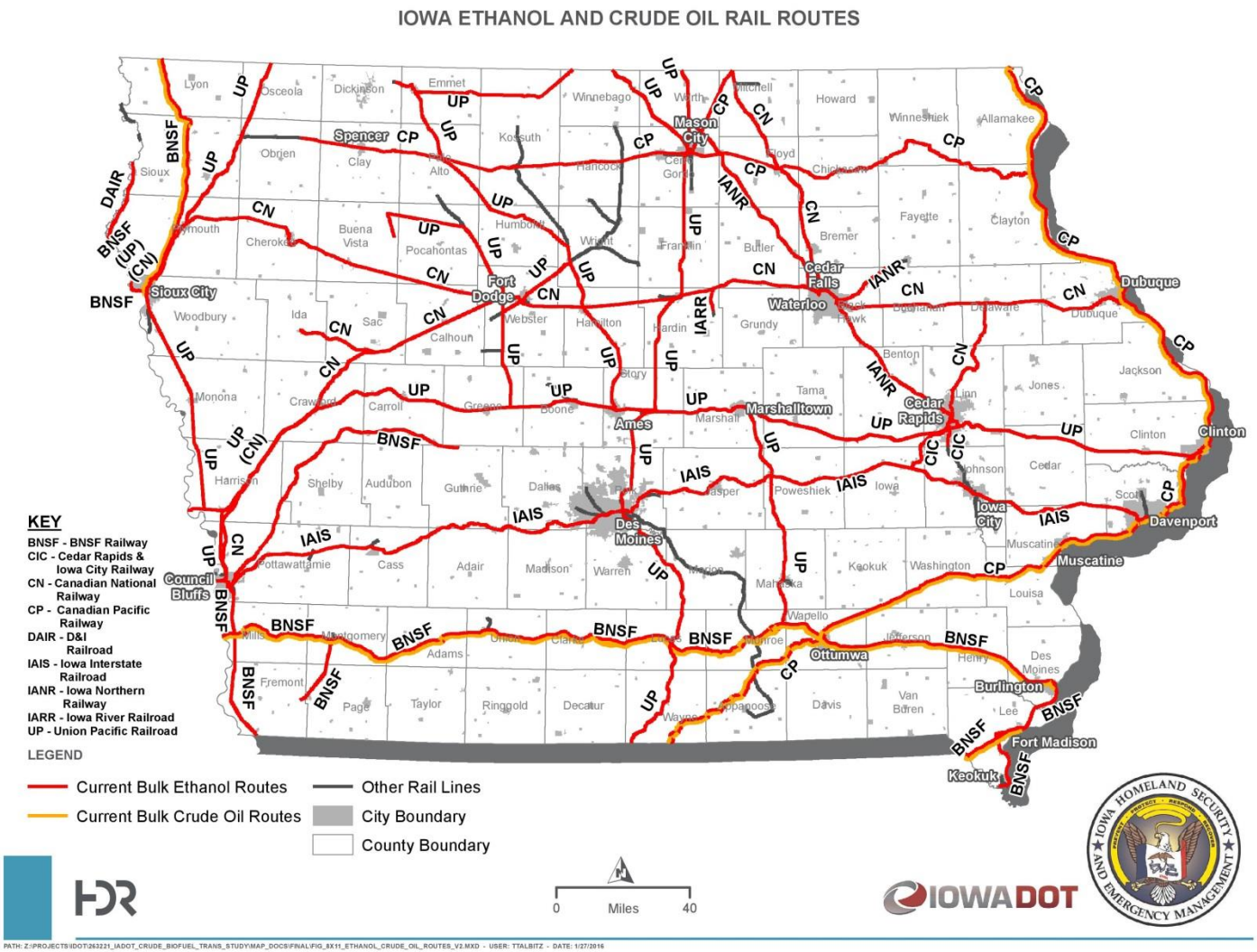
directly serve these refineries; however, some refineries use truck to haul ethanol short distances to loading terminals on railroads, in particular to gain access to more than one railroad in order to obtain competition for transportation. The Study Team overlaid the locations of Iowa's ethanol refineries on Iowa's rail routes to develop a map showing the current and likely potential routes for ethanol by rail, as shown in Figure 6, Current Iowa Railroad Routes for Crude Oil and Ethanol. Section 9.0 of this Study details each railroad route currently used for the transportation of crude oil and ethanol.

Figure 5. Iowa Biodiesel Ethanol Map



Source: Iowa DOT (2015)

Figure 6. Current Iowa Railroad Routes for Bulk Crude Oil and Ethanol Transportation



Source: HDR, as of 1/27/2016

7.4 Long-Term Potential Energy Market Trends Impacting Rail Transportation of Crude Oil and Ethanol in Iowa

7.4.1 Crude Oil Trends

According to the U.S. Department of Energy – Energy Information Administration (EIA), short-term crude oil production trends are expected to go down from current levels (9.4 million barrels per day [or b/d] in the first half of 2015) to 8.7 million b/d by August 2016.[48] From there, production begins rising in late 2016, returning to an average of 9.0 million b/d in the fourth quarter. With this being said, crude-by-rail routes will likely use the same pattern for the next several years. The outlook beyond 2016 deals with uncertain global economic conditions that could affect domestic crude oil supply and demand, as well as regulatory changes that could affect the transportation of crude by rail. Regulatory changes that could restrict rail transportation of crude oil and ethanol, either outright routing restrictions or economic impacts that render rail transportation uneconomic, rail could shift the current crude oil carried by rail to pipeline or strand inland oil supplies from reaching coastal refineries.[49] Additionally, imposing a "uniform national speed limit" for crude oil unit trains could degrade the nation's railroad network fluidity and efficiency, and it could result in network congestion.

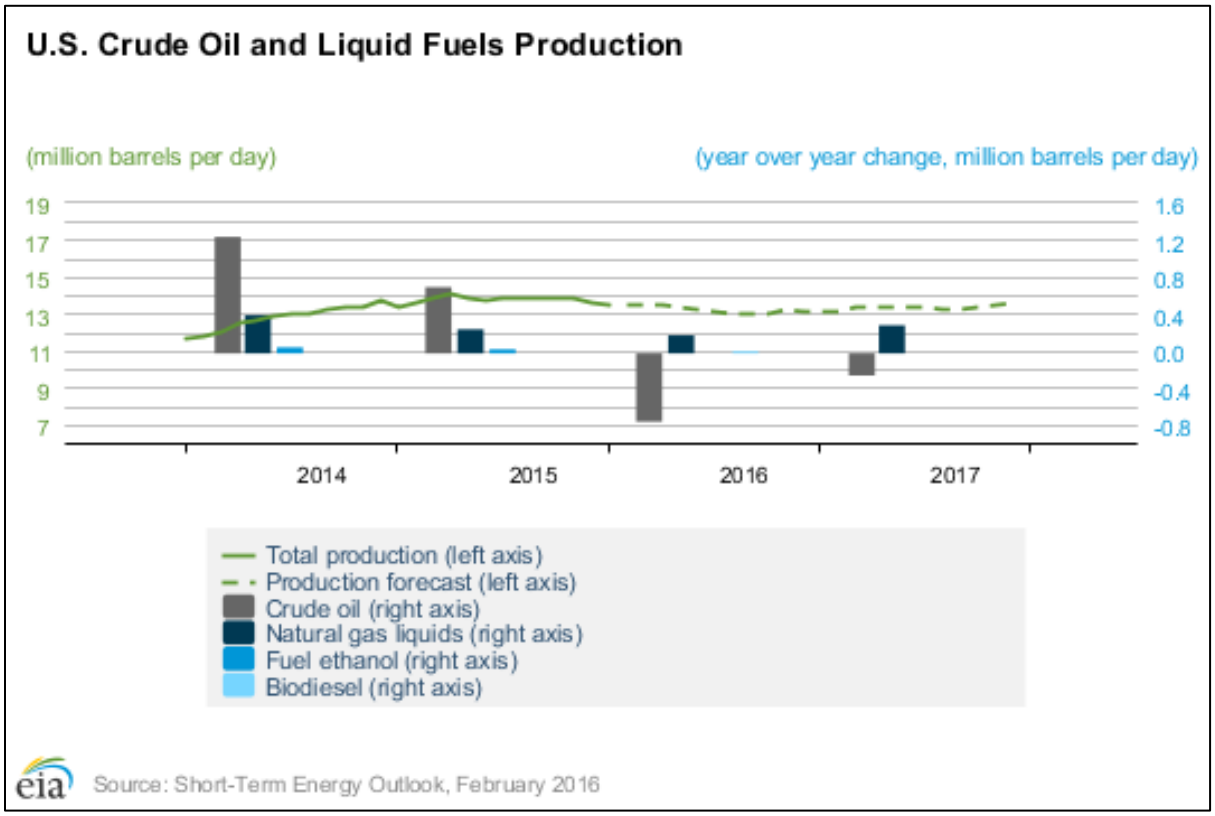
In the short term, rail transportation of crude oil in the U.S. can be expected to slowly decline from its current levels. In the long term in the U.S., it is unlikely that pipeline construction will completely render rail transportation uneconomic, as pipelines are fixed, costly investments that require lengthy contractual volume commitments to fund construction, whereas rail transportation can react immediately to market conditions and absorb production fluctuation from producing regions for which pipeline capacity would be uneconomic. From an Iowa perspective, crude oil volumes by rail can be expected to decline somewhat in the short term, but not reach zero.

See Figure 7 for U.S. Crude Oil and Liquid Fuels Production Projections.

[48] U.S. Department of Energy – Energy Information Administration, *Forecasts*, http://www.eia.gov/forecasts/steo/report/us_oil.cfm

[49] Progressive Railroading, http://www.progressiverailroading.com/rail_industry_trends/article/Rail-Outlook-2015-Freight-and-passenger-railroad-leaders-discuss-the-year-ahead--42853

Figure 7. U.S. Crude Oil and Liquid Fuels Production



Source: U.S. Energy Information Administration (February 2016)

7.4.2 Ethanol Trends

The Study's producer/shipper interviews indicated that Iowa's current distribution pattern for ethanol is unlikely to change. The interviewed producer/shippers stated they anticipated an increase in ethanol demand in coastal and high-population areas, requiring that more unit train shipments of ethanol will be moving toward these areas. (Unlike crude oil, ethanol is not economically feasible for pipeline transportation for long distances.) One producer/shipper noted that the volume of ethanol moving in mixed train (also known as manifest train) shipments to the West Coast is expected to increase. Total future ethanol-volume trends are expected to have small growth, absent regulatory requirements to increase use of renewable fuels or reduce air emissions further. However, the potential regulatory and policy changes, mentioned in the crude oil section above, could have similar impacts to ethanol-by-rail transportation.

In the short term, rail transportation of ethanol in the U.S. can be expected to increase slowly from its current levels. In the long term in the U.S., there is potential for a substantial increase in ethanol train volumes. From an Iowa perspective, ethanol volumes by rail can be expected to gradually increase in the short term, with potential for significant long-term increase should federal air emissions or renewable fuel policy require a higher ethanol blend into gasoline.