ATTACHMENT A
(TO DECLARATION OF ALEC ROBERTS)

Rail Traffic Congestion:

Economic losses to agricultural sectors if oil transported by the Dakota Access Pipeline shifts to rail

Analysis and Projections made by:
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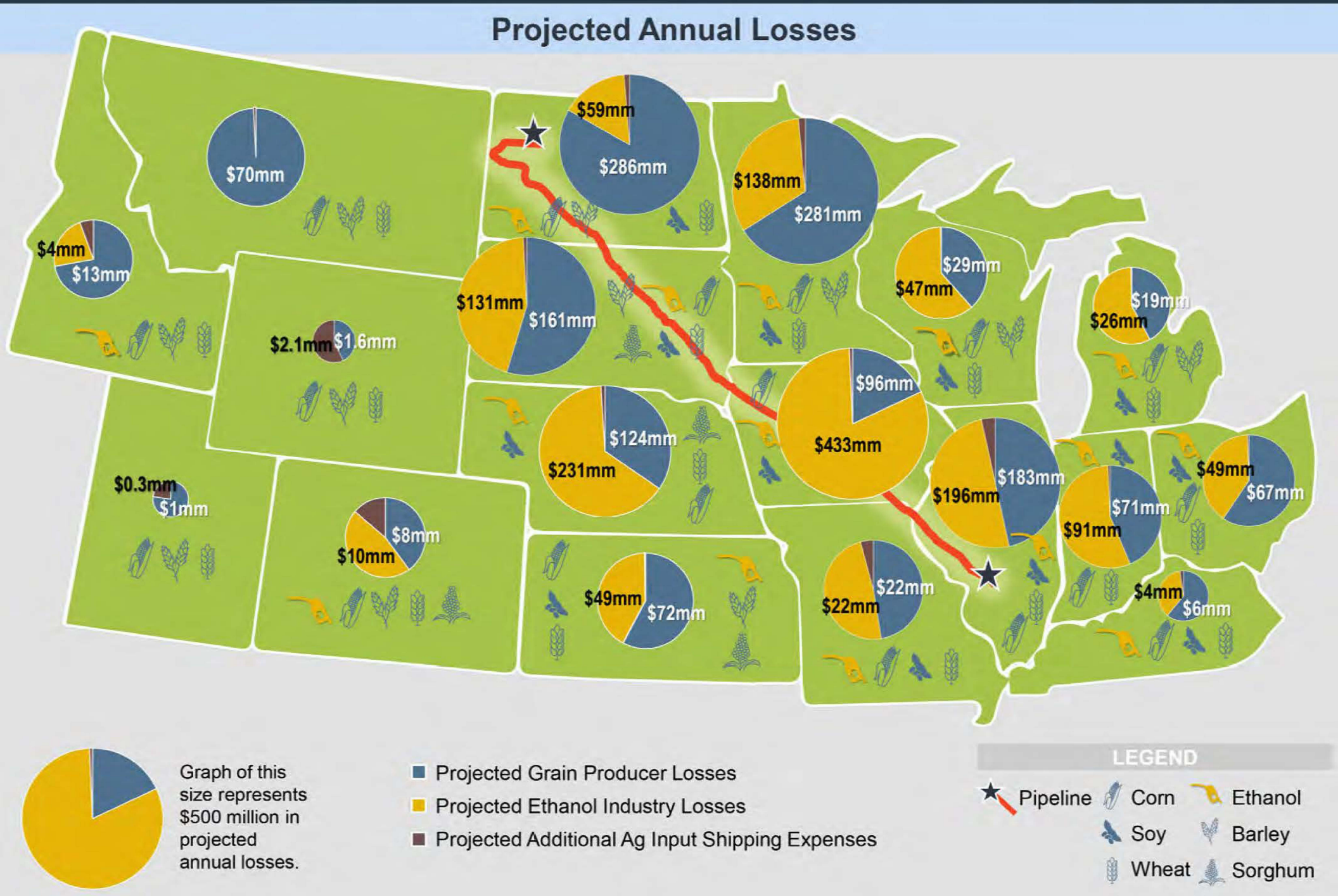


Projected Annual Losses

	Grain Producers	Ethanol Industry	Ag Inputs	Total Estimated Losses
IOWA	$95,868,366	$432,923,656	$3,509,220	**$532,301,243**
MINNESOTA	$280,863,825	$137,801,210	$6,640,634	**$425,305,669**
ILLINOIS	$182,545,219	$195,795,741	$13,466,518	**$391,807,478**
NEBRASKA	$123,923,976	$230,752,278	$3,718,052	**$358,394,306**
NORTH DAKOTA	$285,596,546	$53,525,067	$4,377,724	**$343,499,337**
SOUTH DAKOTA	$160,744,874	$130,738,444	$2,372,058	**$293,855,376**
INDIANA	$71,192,937	$90,655,332	$1,183,104	**$163,031,372**
KANSAS	$72,237,753	$48,687,970	$611,338	**$121,537,062**
OHIO	$67,046,109	$48,648,153	$313,040	**$116,007,302**
WISCONSIN	$29,188,415	$46,698,728	$93,470	**$75,980,613**
MONTANA	$70,358,571	–	$611,390	**$70,969,961**
MISSOURI	$22,012,868	$22,438,387	$1,938,248	**$46,389,503**
MICHIGAN	$19,035,964	$26,029,021	$103,896	**$45,168,881**
COLORADO	$8,222,500	$9,569,976	$2,830,646	**$20,623,122**
IDAHO	$13,052,097	$4,035,502	$1,018,082	**$18,105,681**
KENTUCKY	$5,912,962	$3,564,693	$226,122	**$9,703,776**
WYOMING	$1,612,070	–	$2,140,268	**$3,752,338**
UTAH	$1,011,540	–	$295,464	**$1,307,004**

Grain Producer Losses

Lower farm receipts for grain. Shippers pass back freight costs to farmers via lower grain bid prices. The competitive basis landscape shifts for all grain, not only rail-shipped grain along the precise route of DAPL's displaced oil.

Ethanol Industry Losses

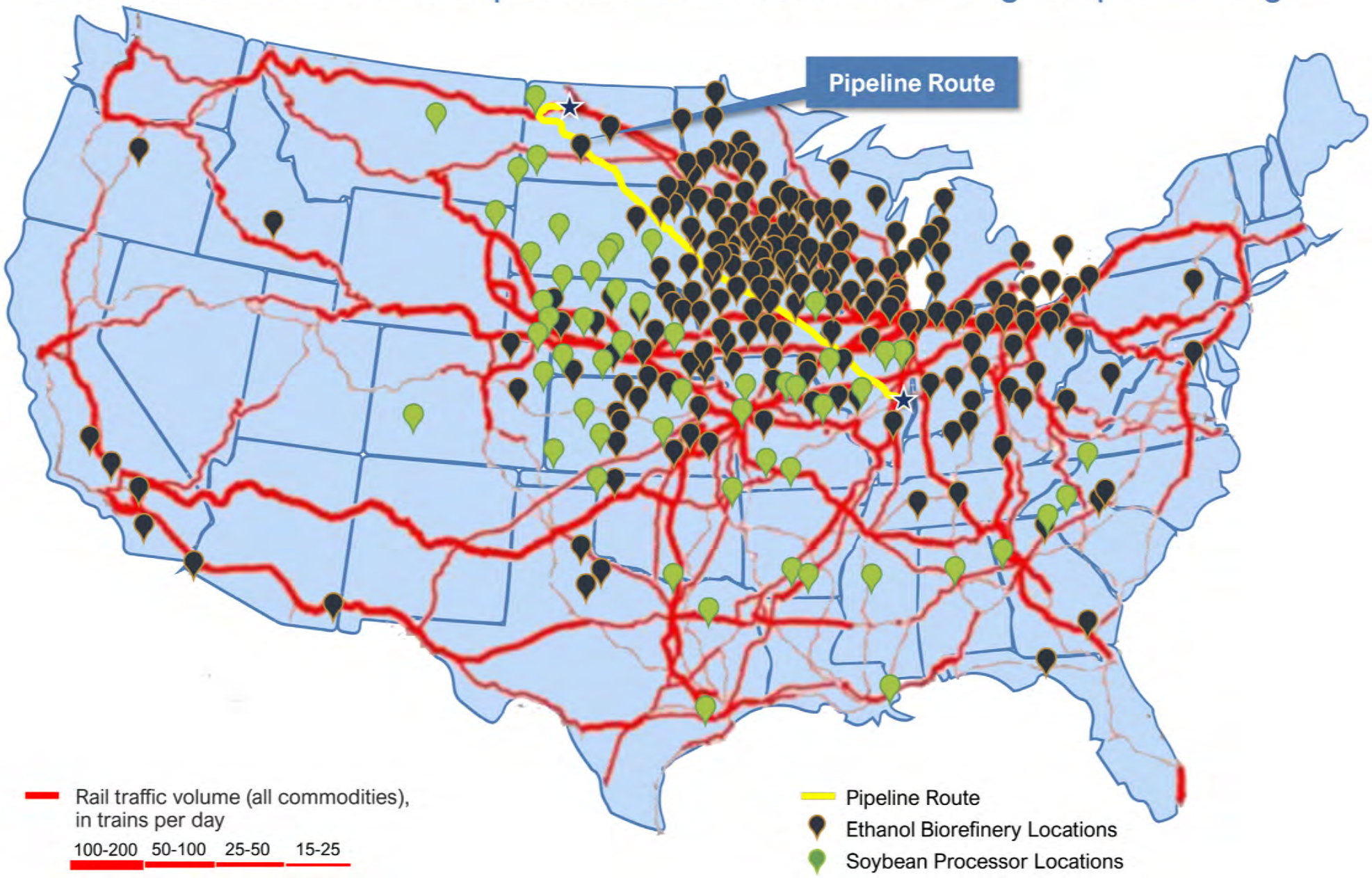
Processors must pay increased freight costs and lose production when rail service cannot be delivered in a timely manner. Railroad resources (tanker cars, locomotives) get enlisted to oil movement.

Ag Input Losses

Higher freight costs for ag retailers and their customers. The fertilizers and agricultural chemicals (herbicides, fungicides) that are necessary to produce crops also rely on rail service to reach their destinations and will rise in price as freight costs increase.

Rail Freight Competition:

Nationwide interrelationship between oil movement and grain processing



Ethanol data @ https://ethanolrfa.org/resources/ethanol-biorefinery-locations
Soybean data @ https://www.soymeal.org/processors/
Trains per Day: Oak Ridge National Laboratory analysis of Freight Analysis Framework version 3.4, 2012

Economic losses resulting from freight congestion due to a shift in oil flows from DAPL to the Midwest rail system:

$3+ BILLION

In Total Annual Losses to the Ag Industry

$1.51 BILLION

In Annual Losses to Grain Producers

$1.48 BILLION

In Annual Losses to the Ethanol Industry

$0.45 BILLION

In Annual Losses due to increased Ag Input Shipping Expenses

Projected Annual Losses

Analysis and Projections Made by Elaine Kub, CFA, Agricultural Economist, June 2023

Executive Summary

If the oil currently flowing on the Dakota Access Pipeline (DAPL) were to instead shift to the Midwest rail system as a means of transport, the Midwest agricultural sector could suffer more than $3 billion in annual losses.

DAPL is a 1,172-mile oil pipeline which is currently capable of transporting 750,000 barrels of oil per day from the Bakken oil fields in North Dakota to a terminal in Patoka, Illinois. DAPL's current capacity can accommodate approximately 65%[1] of North Dakota's oil output and more than 6%[2] of national oil production, providing freight capacity equivalent to more than 1,100 rail cars per day that would otherwise congest the Midwest rail system. This analysis quantifies the effect, in economic terms, on the agriculture industry if the oil flowing on DAPL were to shift to the Midwest rail system. Its conclusions rely on an economic natural experiment from history — comparing the periods when oil was moving from North Dakota to the Midwest in large volumes by rail (prior to construction of DAPL) versus the periods when the oil has been transported by pipeline (after construction of DAPL).

The agriculture industry is uniquely dependent on efficient rail systems to transport commodities over long distances. Less than a decade ago, it experienced a demonstration of just how vulnerable it is. In 2013 and 2014, before DAPL began operations, the 40-65% of the Bakken region's oil output that has since flowed on DAPL instead flowed on Midwestern rail routes. The resultant rail congestion caused severe bottlenecks in the Midwest rail system. The economic hardship experienced by the agriculture industry as a result of that congestion is well documented. The USDA estimated[3] grain and oilseed producers throughout the Upper Midwest may have received *$570 million* less for the crops they marketed in 2014 than they could have earned in a normal freight environment. This rail congestion also increased freight costs nationwide, affected farmers throughout the Corn Belt, and led to ethanol plants shutting down production for lack of rail cars to ship their products.

This analysis considers data from multiple sources and timeframes to highlight illustrative scenarios that can help to predict what may happen to agricultural markets if similar freight congestion were to occur and affect present-day volumes of commodity transportation. Past research shows how grain basis bids were damaged in the 2013-2014 scenario compared to (a) a 2009 "normal" condition, and (b) a post-DAPL condition when the markets returned to "normal" function without oil train congestion. Estimates are made based on those insights and applied to projected 2023 annual shipping volumes which are considerably higher than they were during the 2013-2014 time frame.

If flows on DAPL were to shift to the Midwest rail system, and freight congestion were to occur that was similar (or worse) than what occurred in 2013-2014, **the agriculture industry should expect to lose over $3 billion per year.** The economic losses would come from at least three sources:

1. Freight costs passed back to farmers in the form of weaker grain bids. May lead to **$1.51 billion** in annual losses.
2. Increased freight costs for processed ag commodities and a loss of 9% of annual ethanol production. May lead to **$1.48 billion** in annual losses to the ethanol industry.
3. Higher freight costs to ship ag inputs (e.g. fertilizer) by rail. May cost ag retailers and farmers **$45 million** more annually to receive necessary products.

1 April 2023 NDPA production report (https://ndpipelines.files.wordpress.com/2023/04/ndpa-april-17-2023-press-slides.pdf) forecasted 1.16mm bbls for February 2023. 750k/1.16mm = 64.65%.

2 Jan 2023 EIA short term outlook (https://www.eia.gov/outlooks/steo/) forecasted 12.4mm barrels per day. 750k/12.4mm = 6.05%.

3 Rail Service Challenges in the Upper Midwest: Implications for Agricultural Sectors – Preliminary Analysis of the 2013-2014 Situation. United States Department of Agriculture Office of the Chief Economist and the Agricultural Marketing Service. January 2015.

PAST RESEARCH

In 2013 and 2014, Bakken crude oil was largely transported by rail, creating intense congestion in Midwest rail systems. In 2014 and 2015, a collection of economic studies was performed to quantify the effects on grain markets and farm income due to the oil-induced rail freight congestion of 2013 and 2014. These include the Soy Transportation Coalition's survey response update, "2014 Harvest: Attaching a Garden Hose to a Fire Hydrant," (December 8, 2014), the United States Department of Agriculture (USDA) Office of the Chief Economist's analysis, "Rail Service Challenges in the Upper Midwest: Implications for the Agriculture Sectors," (January 2015), and a study written by this author and published by the American Farm Bureau Federation, "Insufficient Freight: An Assessment of U.S. Transportation Infrastructure and Its Effects on the Grain Industry," (June 2015) (*Insufficient Freight*).

Insufficient Freight concluded:

> "When rail is the only reasonable transportation solution for farmers in certain regions, like the Upper Midwest, rail service providers have the agriculture industry at their mercy, and insufficient service threatens the industry's ability to operate. It's therefore imperative for the agriculture industry to encourage infrastructure projects that take congested freight volume off the rail lines and add that capacity to the overall system … Expansion of U.S. pipeline capacity … represents the best alternative to add overall freight system capacity and relieve the congestion that has threatened grain movement during recent marketing years. Crude oil and fuels can be moved cheaply through pipelines without disrupting the already-crowded freight hubs, without congesting traffic in communities, and without even altering the landscape or agricultural use of the land where the pipeline passes."

This conclusion has been proven accurate.

Table 1: Measures of pre- and post-DAPL rail service and grain market effects
Source: Elaine Kub analysis

	Pre-DAPL Congested scenario *November 2014*	Post-DAPL Normal scenario *March 2020*
Grain shuttle train cost[4] AMS Shuttle Cost Index, inclusive of fuel surcharge, baseline year 2000 values = 100	411 *(peak on 10/1/2014)*	224
Grain train speeds	19.8 mph	23.7 mph
Grain train origin dwell times	35.0 hours	15.7 hours
Ethanol train origin dwell times	35.8 hours	17.1 hours
Northern Plains corn basis[5] versus benchmark futures price	minus $0.95	minus $0.65
Central Corn Belt corn basis versus benchmark futures price	minus $0.40	minus $0.05

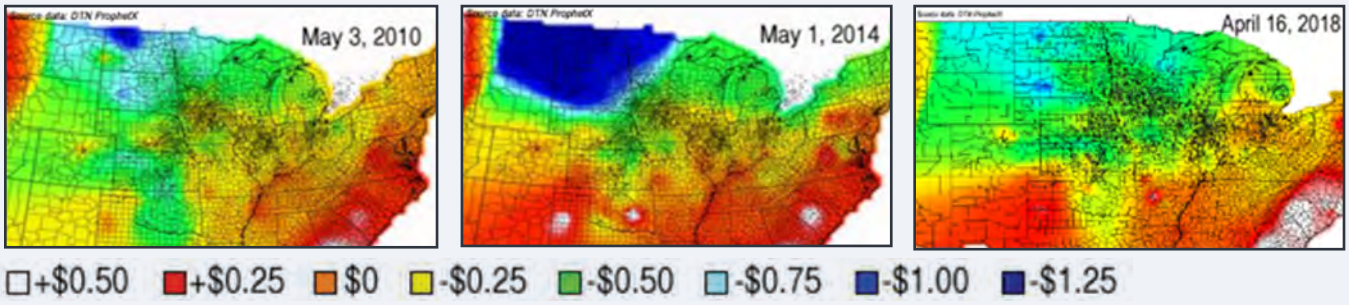
After DAPL came online in 2017, it relieved much of the oil-induced congestion in Midwest rail markets. A follow-up analysis made by this author in 2020 concluded that "grain basis values reverted to their historic means once the [rail-congesting Bakken crude oil] was instead moved by pipeline and the congestion on the rail lines was relieved. Faster train speeds and shorter origin dwell times showed the efficient functioning of the grain-by-rail supply chain." That analysis also showed, via linear regression models of local grain basis bids[6] and the USDA Shuttle Train Cost Index[7], that higher rail freight prices not only depress grain prices in the Upper Midwest states that are most heavily reliant on rail service, but in other Midwestern states, as well.

4 Grain Transportation Report Datasets https://www.ams.usda.gov/services/transportation-analysis/gtr-datasets.

5 DTN Market Tracker database of local grain basis bids https://www.dtnpf.com/agriculture/web/ag/markets/local-grain-bids
"Basis" is a commodity's local price offset from the benchmark futures contract (a local grain elevator's price of $3.00 per bushel might compare to the Chicago corn futures price at $3.50 and be called "minus $0.50" local basis). Stronger (less negative) basis values are more favorable for farmers. To compare grain market scenarios across timeframes, we use basis values instead of flat price values. Corn prices may have been $5 per bushel in 2008 and $3 per bushel in 2020 for a multitude of reasons unrelated to the corn market's own supply and demand (geopolitical factors, investment flows, outside market influence). Meanwhile, the local basis values directly express the supply and demand of the physical commodity moving through a supply chain and can be compared across geography and across time.

6 DTN Market Tracker database of local grain bids https://www.dtnpf.com/agriculture/web/ag/markets/local-grain-bids.

7 Grain Transportation Report Datasets https://www.ams.usda.gov/services/transportation-analysis/gtr-datasets.



- **Grain basis values tend to be weaker in the west where longer transportation distances add to freight costs** (e.g. -$0.60 would be a fairly normal springtime basis value for corn at Fargo, ND). Basis values tend to be stronger in the eastern Corn Belt because of the strong competition between multiple end markets (e.g. $0.00 would be fairly normal for corn near Chicago, IL, where the physical price should in theory match the Chicago futures price).
- **Hotspots exist at end users' locations, where basis bids reflect the cumulative transportation costs** (e.g. cattle feed yards in the Texas panhandle and export facilities at the Gulf of Mexico typically pay prices above the benchmark futures value, or 'positive basis').
- **Unprecedented volumes of crude oil tankers clogged the rail lines** and prevented timely service to other industries, including to grain shippers.
- **This led to higher freight costs and subsequently, profoundly depressed basis values** in the regions where rail congestion was most disruptive and where the grain was uniquely dependent on rail transportation to reach a market.
- **Pain points (late arrivals and drastically elevated basis values) were also noted** in terminal grain customers' prices (e.g. feedlots, poultry feeders in the Southeast, etc).[8]
- **Grain basis values reverted to their historic means once the crude oil was instead moved by pipeline** and the congestion on the rail lines was relieved.
- **Faster train speeds and shorter origin dwell times showed the efficient functioning** of the grain-by-rail supply chain.

Figure 1: Corn basis values during various freight scenarios

Source: Elaine Kub 2020 analysis

8 Bushnell, James B., Jonathan E. Hughes, and Aaron Smith. Food versus Fuel? Impacts of the North Dakota Oil Boom on Agricultural Prices. Journal of the Association of Environmental and Resource Economists. January 2022. Web: https://doi.org/10.1086/716522

Agricultural Dependency on Rail

Efficient transportation is crucial to agriculture. It is necessary to be able to provide safe, affordable, and abundant food, feed, fiber, and fuel to consumers who may be located very far away from the fields in which these commodities are grown or the plants in which they are processed.

Freight flows by highway, railway, and waterway, 2018 (all commodities)

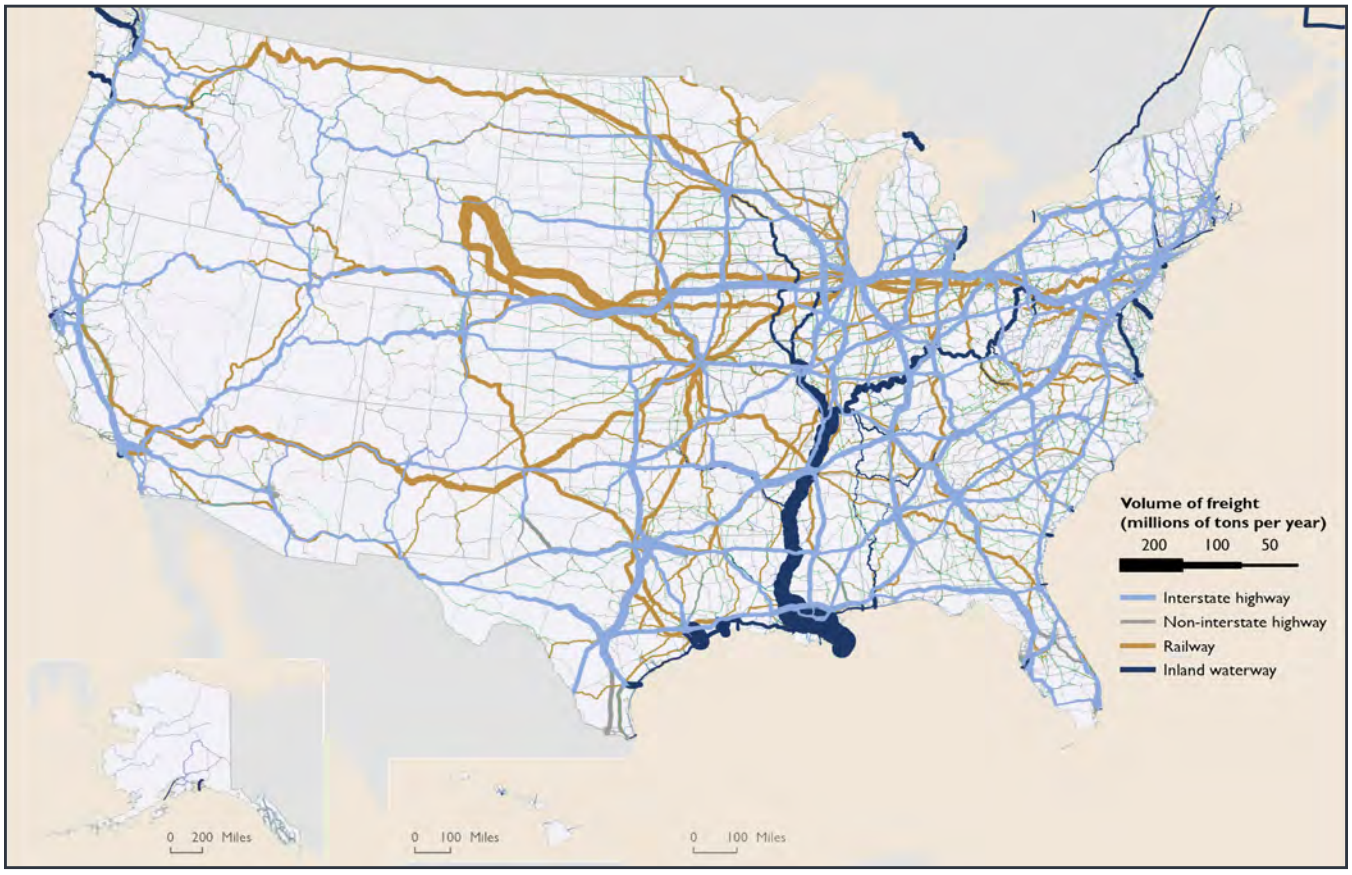


Figure 2: Freight flows by highway, railway, and waterway, 2018 Highway flows depicted in the map are based on the Freight Analysis Framework data from 2015. Waterway and port tonnages are based on data for 2017, and rail is based on 2016 data.

Source: Highway: U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.5, 2019. Rail: USDOT, Federal Railroad Administration, 2019. Inland Waterways: U.S. Army Corps of Engineers, Institute of Water Resources, Annual Vessel Operating Activity and Lock Performance Monitoring System data, 2018.

Certain regions and states are more reliant on rail service than others, mostly as a function of their geographic distance from either domestic population centers or from coastal export facilities. A bushel of grain grown in Iowa, for instance, has multiple market routes: it may move by truck to a local livestock feeder or a local ethanol plant for domestic use; it may get routed to a rail shipper for ultimate use in domestic consumption or for export; or it may get routed to a barge shipper that will ultimately load the grain on an ocean-going vessel for export. In contrast, a bushel of grain grown in North Dakota has virtually only one feasible market route — to be loaded onto a train bound for the Pacific Northwest to be exported to Asia.

Table 2: Share of grain shipped by rail

Source data: USDA Agricultural Marketing Service's "State Grain Rail Statistical Summary"[9]

	Share of Grain **Shipped by Rail**
COLORADO	*Net Importer*
IDAHO	32.4%
ILLINOIS	31.4%
INDIANA	27.8%
IOWA	15.9%
KANSAS	35.4%
KENTUCKY	9.1%
MICHIGAN	20.4%
MINNESOTA	37.5%
MISSOURI	14.7%
MONTANA	84.6%
NEBRASKA	35.2%
NORTH DAKOTA	79.2%
OHIO	38.8%
SOUTH DAKOTA	43.7%
UTAH	*Net Importer*
WISCONSIN	21.6%
WYOMING	*Net Importer*

While any bushel of grain used domestically will almost certainly rely on truck shipping at some point (to be transported out of its field of origin, if nothing else), exported grain tends to rely heavily on rail transportation because the coastal export facilities are located long distances from the rural origins of the grain, and not all rural grain origins have access to the relatively cheap barge freight system.

Note that grain shipped in 2022 and 2023 that typically could access the barge freight system may be more heavily reliant on rail transport as a result of the effect the Mississippi River's current low water levels have on barge transportation rates and shipping times. In its October 20, 2022 Grain Transportation Report, the USDA explained that:

> "Throughout [2022], the barge industry has struggled with higher fuel costs and a shortage of workers that has delayed shipments by 1-2 days. Throughout the third quarter, the Lower Mississippi River (LMR) was plagued by low water levels, which exacerbated delays. Most recently, low levels not seen since 1988 have led to reduced flows, reduced tow sizes, and grounded barges. As a result, portions of the river have closed, at times for periods of 12-36 hours. These multiple river challenges have driven third-quarter barge rates higher than they would rise during a typical harvest."[10]

9 2014 State Grain Statistics https://www.ams.usda.gov/services/transportation-analysis/research/rail/statistics

10 U.S. Department of Agriculture, Agricultural Marketing Service. Grain Transportation Report. October 20, 2022. Web: http://dx.doi.org/10.9752/TS056.10-20-2022.

Potential Shift in DAPL Oil Flows to Midwest Rail Systems

A shift in DAPL oil flows to Midwest rail systems would have a significant impact on freight costs and availability throughout the Midwest and nationally. Because nationwide freight cost increases affect all agricultural shippers – from local elevators in North Dakota to ethanol plants in Ohio – any analysis of economic impacts to the agriculture industry in the event of a shift in DAPL oil flows must consider not only the effects in regions where DAPL is currently running (and where oil trains full of displaced Bakken oil would subsequently run), but also the rest of the nation's primary grain-producing regions.

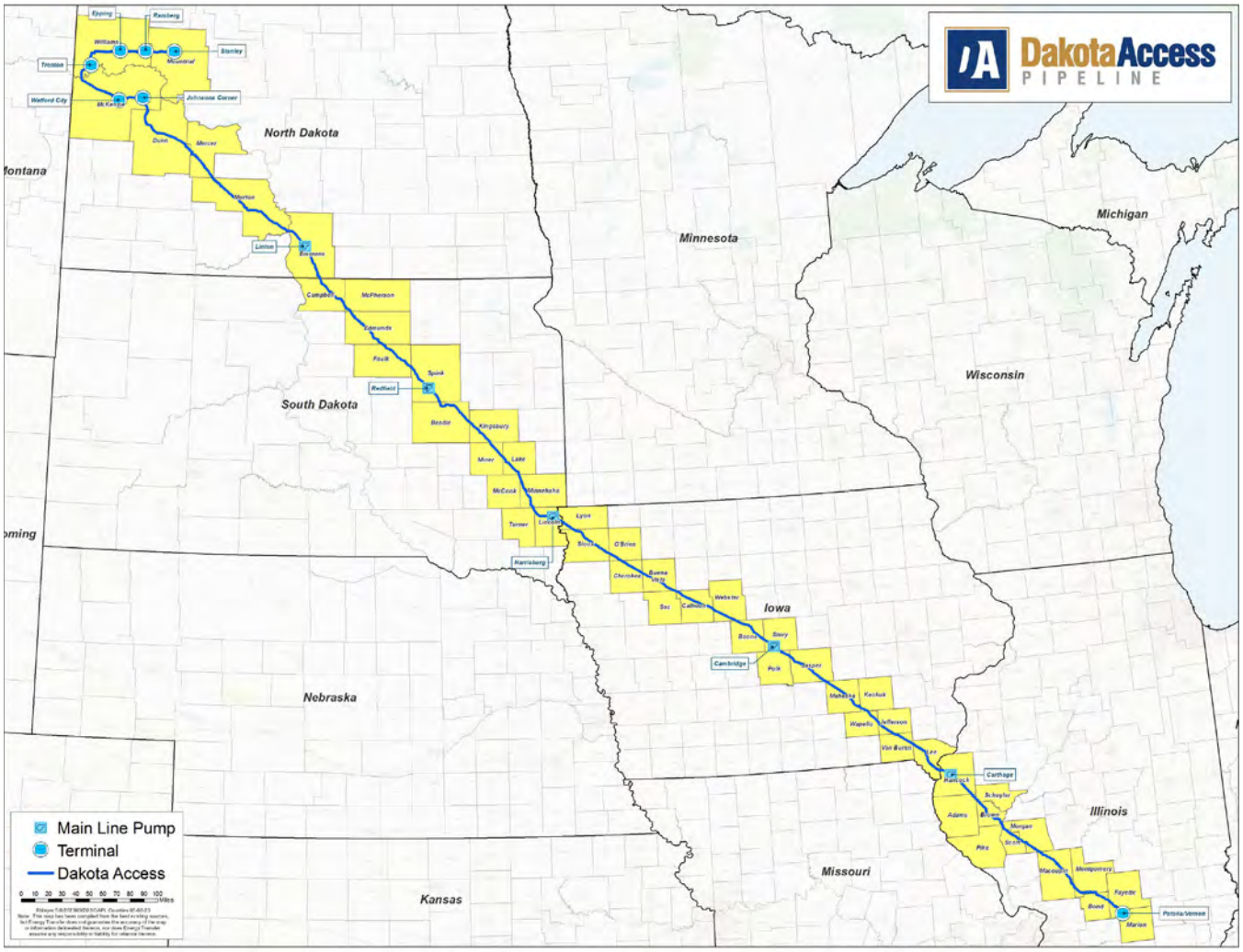


Figure 3: Dakota Access Pipeline route
Source: Energy Transfer

Projected impacts of a shift in DAPL oil flows on the economics of the agriculture industry can be considered in light of the known observations from previous scenarios:

Pre-DAPL 2013-2014 oil-induced congestion

- Freight bids for shipping grain in a shuttle train skyrocketed as high as $5,875 per car on the secondary market.[11]
- The higher freight costs affected farmers as basis got weaker (i.e. more negative), resulting in prices as much as $0.46 less for each bushel of grain than would otherwise be the case.[12]
- On a rail system congested with oil trains, average train speeds fell. Dwell times (the period after a train has been loaded but before it's hauled by the railroad's locomotives) reached 14 days across much of Upper Midwest, and at one point averaged 29 days across North Dakota. **'Plugged' up elevators could no longer accept grain to store in their facilities.** In response to these "acute service issues," the Surface Transportation Board began requiring Class I rail carriers to provide weekly data showing rail service performance.[13]
- Meanwhile, equally poor service for the tanker cars used by ethanol producers caused shutdowns and lost ethanol production. **Nationwide losses "amounted to 80,000 barrels per day between December 2013 and March 2014,"** according to Renewable Fuels Association President Bob Dinneen at the time.[14] These losses were equivalent to 9% of national production.
- The average freight cost to ship agricultural inputs (e.g. fertilizer or herbicide) increased to as much as $876 per ton.[15]

Nationwide ethanol production losses "amounted to 80,000 barrels per day between December 2013 and March 2014."

Renewable Fuels Association President Bob Dinneen

11 Grain Transportation Report Datasets Table 5 https://www.ams.usda.gov/services/transportation-analysis/gtr-datasets.
12 Rail Service Challenges in the Upper Midwest: Implications for Agricultural Sectors – Preliminary Analysis of the 2013-2014 Situation. Web: https://doi.org/10.1086/716522.
13 Rail Performance Metrics https://agtransport.usda.gov/stories/s/Rail-Dashboard/appm-bhti.
14 Rail Delays Hitting Home for Ethanol, Grain Shippers https://www.farmprogress.com/farm-business/rail-delays-hitting-home-for-ethanol-grain-shippers.
15 Carload Waybill Sample https://www.stb.gov/reports-data/waybill/.

During DAPL operation, 2017 to present

- The secondary market for shipping grain by rail falls back to historically normal $0 per car (average bid).[16]
- Grain basis bids return to normal levels based on local supply-and-demand, varying by location as seen in Figure 1, but in the eastern Dakotas settling at roughly 50 cents under the futures price.[17]
- Origin dwell times for loaded grain shuttles fall back to a matter of hours, not days. In the March 2020 post-DAPL normal scenario, grain train origin dwell times average 15.7 hours, showing timely seasonal service by the railroads.[18]
- Nationwide ethanol production surges to 16 billion gallons per year, or 20% higher than was seen during the congested period.[19]
- The average freight cost to ship agricultural inputs, like fertilizer or herbicide, falls by approximately 3% to $850 per ton. For nitrogen fertilizer solution, specifically, the freight cost falls from $500 per ton to $453 per ton, a drop of 9%.[20]

Potential DAPL flow shift scenario

- Predicted rail service challenges due to freight congestion that would take place in 2023 would be more severe than the scenario observed in 2013-2014, because the rail system is already more burdened with a higher volume of commodities. Nationwide grain production is projected to be 10% higher in 2023[21] than in 2013 (e.g. 15.265 billion bushels of corn compared to 13.831 billion bushels in 2013). Similarly, 2023 ethanol production may be 14% higher (15.2 billion gallons per year) compared to 2013's volume (13.3 billion gallons), with a growing portion of that production likely to be exported and therefore needing to be shipped by rail.[22]
- Freight costs passed back to farmers at the same scale seen in 2014 ($0.42 per bushel of corn or sorghum shipped by rail, $0.27 per bushel of soybeans, $0.46 per bushel of wheat or barley) may lead to **$1.5 billion in annual losses out of farmers' pockets.**[23]
- Increased freight costs and a loss of 9% of 2023 ethanol production may lead to **$1.4 billion in annual losses to the ethanol industry.**[24]
- Higher freight costs to ship ag inputs by rail may cost ag retailers and farmers **$45 million more to receive their necessary fertilizers and chemicals by rail.**[25] In a fertilizer market with persistent high prices[26] due to geopolitical developments and high energy prices (remaining above 5-year averages in May 2023), agricultural producers would be alarmed to experience freight scarcity and uncertainty on top of market scarcity and uncertainty.

16 Grain Transportation Report Datasets Table 5 https://www.ams.usda.gov/services/transportation-analysis/gtr-datasets.
17 DTN Market Tracker database of local grain bids https://www.dtnpf.com/agriculture/web/ag/markets/local-grain-bids.
18 Agricultural Rail Service Metrics Dashboard https://agtransport.usda.gov/stories/s/Agricultural-Rail-Service-Metrics-Dashboard/jxpf-zf6y/
19 Table 12 Ethanol plants.
20 Carload Waybill Sample https://www.stb.gov/reports-data/waybill/.
21 USDA Office of the Chief Economist https://www.usda.gov/oce/commodity/wasde/wasde0523.pdf.
22 Figure 6 Use of STB Waybill Data.
23 Table 19 Conclusions.
24 Table 19 Conclusions.
25 Table 9 Ag inputs (fertilizer, herbicides, etc.).
26 DTN Retail Fertilizer Trends https://www.dtnpf.com/agriculture/web/ag/crops/article/2023/04/26/anhydrous-drops-1-000-per-ton-first.

In a letter to the Surface Transportation Board dated May 12, 2023, U.S. Secretary of Agriculture Tom Vilsack highlighted the deterioration of rail service to agricultural shippers and the rail system's present vulnerability to any unexpected spikes in demand, writing "Rail service … remains inadequate and unreliable for many agricultural shippers … The [present] operating model does not leave sufficient buffer in labor and assets for railroads to be able to handle unexpected spikes in demand … It is of utmost important that the STB moves quickly to strengthen our rail system overall and specifically to improve service to agricultural shippers before railroad capacity again becomes an urgent, national issue."[27]

In 2020 testimony in support of the U.S. Corps of Engineers in litigation relating to DAPL's permits and authorizations, Oliver Wyman partner William J. Rennicke provided modeling and documentation to show that "quickly increasing the volume of crude oil by rail shipped out of the Bakken region by DAPL's [then-]current capacity would rapidly aggravate congestion, cause delays, and crowd out capacity for other commodities on rail routes of vital importance to the Upper Midwest's economy." Specific projections were made to show how rail service would deteriorate in scenarios where extra oil trains travel the rail routes out of the Bakken region.

PROJECTED LEVEL-OF-SERVICE FOR THE MINNESOTA PORTION OF THE RAIL ROUTE FROM BAKKEN TO CHICAGO VIA FARGO, ND

Level-of-Service of E (at capacity) or F (above capacity) increases from 15.9% of route-miles in Minnesota using current volume, to 20.5% of route-miles with half the then-DAPL volume, to 74.2% of route-miles with the full then-DAPL volume, based on the AAR methodology and public data on train volumes and capacity.

Figure 4: Oliver Wyman analysis

See Case 1:16-cv-01534-JEB Document 512-2 (Rennicke Apr. 29, 2020 Declaration) for complete analysis of rail capacity and level-of-service scenarios

27 Letter on Rail Service Issues, Secretary of Agriculture Tom Vilsack https://www.ams.usda.gov/sites/default/files/media/8892306_SignedSecLetterRailService_20230512.pdf.

PROJECTED LEVEL-OF-SERVICE FOR THE MINNESOTA PORTION OF THE RAIL ROUTE FROM BAKKEN TO CHICAGO VIA FAIRMONT, ND

Level-of-Service of E (at capacity) or F (above capacity) increases from 5.0% of route-miles in Minnesota using current volume, to 34.5% of route-miles with half the then-DAPL volume, to 77.2% of route-miles with the full then-DAPL volume, based on the AAR methodology and public data on train volumes and capacity.

Figure 5: Oliver Wyman analysis

See Case 1:16-cv-01534-JEB Document 512-2 (Rennicke Apr. 29, 2020 Declaration) for complete analysis of rail capacity and level-of-service scenarios

Rennicke concludes, "As more trains are added to a rail line, the average delay for all trains increases. A large, sudden increase in trains on a route, as would be the case in the event of [a shift in oil flows], would add delay for all trains using the route."

> **"As more trains are added to a rail line, the average delay for all trains increases. A large, sudden increase in trains on a route, as would be the case in the event of [a shift in oil flows], would add delay for all trains using the route."**
>
> *Oliver Wyman partner William J. Rennicke*

Use of STB Waybill Data

Supporting data for the conclusions drawn in this analysis were largely sourced from the Public Use Waybill file[28] of the Surface Transportation Board's Carload Waybill Sample, which is a stratified sample[29] of carload waybills for all U.S. rail traffic submitted by major rail carriers.

This data documents trends in rail traffic over time and across various geographical regions, split into BEA Economic Areas by the Bureau of Economic Analysis (see Appendix A: BEA Economic Areas by State). For instance, although overall U.S. production of ethanol has dipped in recent years since 2018, the volume of ethanol shipped by rail continues to grow ever-larger year by year.

Annual U.S. Rail Carloads of Ethanol

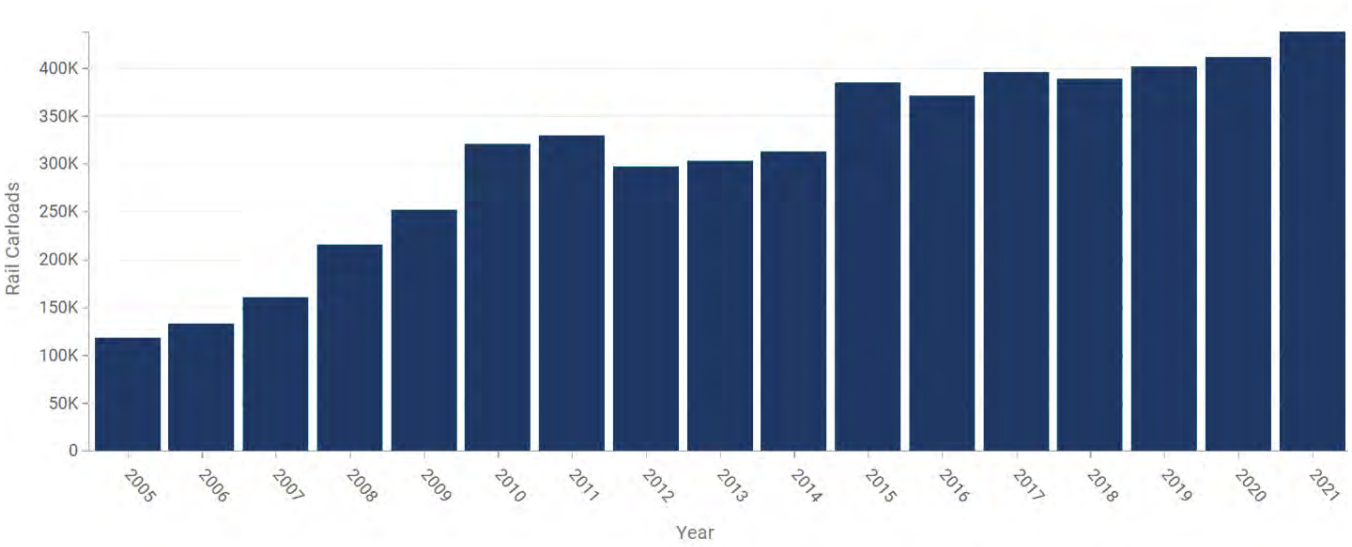


Figure 6: Sample chart from STB waybill data
Source: agtransport.usda.gov

For the purposes of the remainder of this analysis, the STB waybill data was filtered to show agricultural products shipped to or from BEA areas of interest to the agriculture industry, illustrating actual tons of freight moving in or out of specific destinations or origins.

28 https://agtransport.usda.gov/Rail/Public-Use-Carload-Waybill-Sample/xve5-xb56.
29 https://agtransport.usda.gov/api/views/xve5-xb56/files/347e7e6f-a8af-43af-8c24-d766c1480871?download=true&filename=2018-STB-Waybill-Reference-Guide.pdf.

Use of Freight Price Information

USDA's Agricultural Marketing Service maintains datasets of various freight cost indicators — Grain Transportation Report Datasets[30] — including bids and offers for railcars to be delivered in the secondary market (i.e. negotiated between parties outside the railroads' posted tariff rates). These bids and offers represent the current market supply and demand for rail freight that can ship grain by either 'shuttle' train (a dedicated set of 110+ railcars, all loaded with one commodity moving from one origin to one destination) or non-shuttle train. The secondary market is the best indicator of the availability or scarcity of rail freight in times of congestion or poor service.

In early 2023, rail freight for grain shuttles on the secondary market have reverted back to a historically normal $0 per car.[31] That figure is an average encompassing a complex collection of bids and offers that vary by railroad, type of train, and timeframe of delivery, and which are frequently negative values (e.g. -$300 per car bid in early May 2023 for a grain shuttle in the Union Pacific pool for June 2023 delivery). Present averages around $0 per car indicate a balanced supply and demand of available rail freight, and unimpeded rail service levels. This balance would be in danger if DAPL oil flow shifts to the rail system and freight congestion once again occurs. During the freight congestion of 2014, bids for grain shuttles on the secondary market spiked and were commonly noted at +$4,000 per car (~$40 per ton). The highest-ever bid tracked in this dataset was +$5,875 per car bid on October 9, 2014 for a grain shuttle to be delivered that same month on the BNSF rail line.

The following chart shows the spike in railcar bids during the 2013-2014 freight congestion as a broad average across multiple types of bids.

Historical Secondary Auction Market Grain Railcar Bids

This shows the full history (monthly averages) of bids for grain cars in the secondary auction market, broken out by train type.

Figure 7: Monthly average bids for grain cars in the secondary auction market

Source: Transportation & Marketing Programs/AMS/USDA

30 Grain Transportation Report Datasets https://www.ams.usda.gov/services/transportation-analysis/gtr-datasets.

31 Grain Transportation Report Datasets Table 5 https://www.ams.usda.gov/services/transportation-analysis/gtr-datasets.

Economic Implications for Agricultural Producers

In the event of a shift in DAPL oil flows that would once again induce congestion, making reliable rail service scarce to the agriculture industry, this analysis shows agricultural producers (farmers) will suffer economic losses by both paying more for freight charges and earning less for their produced goods. They would experience higher freight costs for inputs like fertilizer and herbicides which are shipped by rail. Simultaneously, they would receive lower prices for their grain as shippers pass back higher freight costs via weaker basis bids.[32]

Grain Basis Bids

The Upper Midwest states of North Dakota, South Dakota, Minnesota, and Montana would bear the most severe direct losses to grain producer income, because a higher proportion of their annual grain production must be shipped long distances by rail. When rail freight costs increase, the grain prices received by farmers in this region tend to collapse in a virtually 1-to-1 relationship.

In a freight-congested environment, each bushel of corn would lose between $0.17 and $0.42 of market value, each bushel of soybeans would lose between $0.11 and $0.27 of market value, and each bushel of wheat would lose between $0.18 and $0.46 of market value (per an analysis made by the USDA Office of the Chief Economist in January of 2015 — "Rail Service Challenges in the Upper Midwest: Implications for Agricultural Sectors - Preliminary Analysis of the 2013-2014 Situation"[33]). After extrapolating those losses across all the rail-shipped grain from those four states, **the USDA estimated grain and oilseed producers throughout the Upper Midwest may have received $570 million less for the crops they marketed in 2014 than they could have earned in a normal freight environment.**

However, even in states where grain producers are less dependent on rail freight, there would still be significant impacts resulting from congestion and nationwide freight cost increases. The entire competitive landscape for grain bids would likely become depressed, with a price sensitivity of approximately 0.5-to-1 (per independent modeling conducted in 2020 by Elaine Kub to confirm the consistency of market behavior over time and across regions, using data from a private database of historical individual basis bids collected daily from over 2,500 locations by DTN ProphetX[34], versus USDA Agricultural Marketing Service's "Shuttle Cost Index.")[35]

The effects of congestion will likely be exacerbated by the expected increase in grain production and shipment. Grain shipment volumes vary from year-to-year and season-to-season, but North American grains are annual crops, and each year's production must ultimately move within a calendar year. Official USDA projections for 2023 grain production volumes published in May 2023 show a recovery from 2022's drought-diminished production.[36] Meanwhile, the spring shipping season continues to handle grain produced in 2022, so those annual production numbers have been used as a proxy for annual shipping volumes.

32 Wilson, W.W. and Dahl, B. (2011), Grain pricing and transportation: dynamics and changes in markets. Agribusiness, 27: 420-434. https://doi.org/10.1002/agr.20277.
33 USDA Analysis of 2013-14 Rail Service Challenges for Senators ThuneKlobuchar.pdf.
34 DTN Market Tracker database of local grain bids https://www.dtnpf.com/agriculture/web/ag/markets/local-grain-bids.
35 Transportation Research and Analysis. USDA Agricultural Marketing Service. https://www.ams.usda.gov/services/transportation-analysis.
36 USDA Office of the Chief Economist https://www.usda.gov/oce/commodity/wasde/wasde0523.pdf.

Table 3: State by state grain production, in bushels

Source data: USDA/NASS

	Share of Grain **Shipped by Rail**	Number of farming Operations	**2022** Corn production	**2022 Soybean** production	**2022** Wheat production	**2022 Barley** production	**2022** Sorghum production
COLORADO	*Net Importer*	38,800	118,580,000	-	35,750,000	4,440,000	7,600,000
IDAHO	32.4%	24,600	23,760,000	-	93,515,000	59,940,000	-
ILLINOIS	31.4%	70,700	2,268,400,000	677,250,000	44,240,000	-	-
INDIANA	27.8%	56,000	974,700,000	335,225,000	19,440,000	-	-
IOWA	15.9%	85,300	2,480,000,000	586,755,000	-	-	-
KANSAS	35.4%	58,500	510,600,000	132,275,000	244,200,000	165,000	105,300,000
KENTUCKY	9.1%	74,800	210,600,000	98,940,000	30,000,000	-	-
MICHIGAN	20.4%	44,300	336,000,000	105,280,000	34,445,000	400,000	-
MINNESOTA	37.5%	68,000	1,460,550,000	369,500,000	73,810,000	3,960,000	-
MISSOURI	14.7%	95,200	502,320,000	275,730,000	24,600,000	-	-
MONTANA	84.6%	26,800	7,728,000	-	139,300,000	34,440,000	-
NEBRASKA	35.2%	45,700	1,455,300,000	278,320,000	26,240,000	-	6,875,000
NORTH DAKOTA	79.2%	26,100	349,770,000	198,450,000	299,900,000	48,180,000	-
OHIO	38.8%	77,800	594,660,000	281,940,000	36,735,000	-	-
SOUTH DAKOTA	43.7%	29,600	661,320,000	192,660,000	71,560,000	324,000	11,900,000
UTAH	*Net Importer*	17,800	2,640,000	-	3,168,000	1,230,000	-
WISCONSIN	21.6%	64,100	545,400,000	116,100,000	18,720,000	165,000	-
WYOMING	*Net Importer*	12,000	8,568,000	-	1,615,000	5,394,000	-

A conservative estimate of the economic losses that would be faced by each state's farmers in 2023 if DAPL's oil flows shift and the nation's rail network became congested with oil trains again, in the manner observed in 2013-2014, was made first by calculating only the number of grain bushels each state would likely ship by rail.

These quantities, certain to be affected by higher rail freight costs in the event of widespread congestion, were then multiplied by the projected per-bushel losses for each class of grain.

In the Upper Midwest states — Minnesota, North Dakota, South Dakota, and Montana — with more limited market options for shipping grain, the projected per-bushel losses were assumed to be the same range documented in the 2015 USDA analysis "Rail Service Challenges in the Upper Midwest: Implications for Agricultural Sectors," specifically $0.17 (low) to $0.42 (high) per bushel of corn or sorghum, $0.11 (low) to $0.27 (high) per bushel of soybeans, or $0.18 (low) to $0.46 (high) per bushel of wheat or barley.

For other states with more complex market options for grain, the projected per-bushel losses were taken from a linear regression model performed in 2020, confirming how grain basis bids weaken overall in an environment of higher rail freight. Practically speaking, although a farmer in Iowa, for instance, may be able to avoid selling grain into a weak rail market, and instead pivot to selling grain to a nearby ethanol plant or livestock feeder, the prices everywhere for that grain will weaken in tandem if the rail market's bids weaken. If the local rail shipper drops its bidding to -50 cents under the futures market for corn from -30 cents under, then the local feedlot won't reasonably continue to bid -30 cents under the futures market; instead, it will allow its bids to sink too.

Therefore, the projected per-bushel losses for the remaining states – Colorado, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Missouri, Nebraska, Ohio, Utah, Wisconsin, Wyoming – were assumed to be $0.09 (low) to $0.21 (high) per bushel of corn or sorghum, $0.06 (low) to $0.14 (high) per bushel of soybeans, and $0.09 (low) to $0.23 (high) per bushel of wheat or barley. These per-bushel loss calculations were conservatively applied only to the share of grain production that each state ships by rail.

For instance, the 'high' range calculation for how much annual income Kansas farmers may lose in a congested freight environment at present-day production volumes would be made as follows:

+ (510,600,000 bushels of corn) x (35.4% shipped by rail) x ($0.21)
+ (132,275,000 bushels of soybeans) x (35.4% shipped by rail) x ($0.14)
+ (244,200,000 bushels of wheat) x (35.4% shipped by rail) x ($0.23)
+ (165,000 bushels of barley) x (35.4% shipped by rail) x ($0.23)
+ (105,300,000 bushels of sorghum) x (35.4% shipped by rail) x ($0.21)

Equals $72,237,753 in combined losses for Kansas farmers

Table 4: Calculated annual losses for various classes of grain due to lower basis bids in a congested-freight environment

LOW RANGE ANNUAL LOSS ESTIMATES

	Rail Corn Losses Low	Rail Soybeans Losses Low	Rail Wheat Losses Low	Rail Barley Losses Low	Rail Sorghum Losses Low	COMBINED
COLORADO	-	-	$3,217,500	-	-	**$3,217,500**
IDAHO	$692,842	-	$2,726,897	$1,747,850	-	**$5,167,589**
ILLINOIS	$64,104,984	$12,759,390	$1,250,222	-	-	**$78,114,596**
INDIANA	$24,386,994	$5,591,553	$486,389	-	-	**$30,464,936**
IOWA	$35,488,800	$5,597,643	-	-	-	**$41,086,443**
KANSAS	$16,267,716	$2,809,521	$7,780,212	$5,257	$3,354,858	**$30,217,564**
KENTUCKY	$1,724,814	$540,212	$245,700	-	-	**$2,510,726**
MICHIGAN	$6,168,960	$1,288,627	$632,410	$7,344	-	**$8,097,341**
MINNESOTA	$93,110,063	$15,241,875	$4,982,175	$267,300	-	**$113,601,413**
MISSOURI	$6,645,694	$2,431,939	$325,458	-	-	**$9,403,090**
MONTANA	$1,111,441	-	$21,212,604	$5,244,523	-	**$27,568,568**
NEBRASKA	$46,103,904	$5,878,118	$831,283	-	$217,800	**$53,031,106**
NORTH DAKOTA	$47,093,033	$17,288,964	$42,753,744	$6,868,541	-	**$114,004,282**
OHIO	$20,765,527	$6,563,563	$1,282,786	-	-	**$28,611,877**
SOUTH DAKOTA	$49,129,463	$9,261,166	$5,628,910	$25,486	$884,051	**$64,929,075**
UTAH	-	-	$285,120	$110,700	-	**$395,820**
WISCONSIN	$10,602,576	$1,504,656	$363,917	$3,208	-	**$12,474,356**
WYOMING	-	-	$145,350	$485,460	-	**$630,810**

Table 5: Calculated annual losses for various classes of grain due to lower basis bids in a congested-freight environment

HIGH RANGE ANNUAL LOSS ESTIMATES

	Rail Corn Losses High	Rail Soybeans Losses High	Rail Wheat Losses High	Rail Barley Losses High	Rail Sorghum Losses High	COMBINED
COLORADO	-	-	$8,222,500	$4,466,729	-	**$8,222,500**
IDAHO	$1,616,630	$1,616,630	$6,968,738	$4,466,729	-	**$13,052,097**
ILLINOIS	$149,578,296	$149,578,296	$3,195,013	-	-	**$182,545,219**
INDIANA	$56,902,986	$56,902,986	$1,242,994	-	-	**$71,192,937**
IOWA	$82,807,200	$82,807,200	-	-	-	**$95,868,366**
KANSAS	$37,958,004	$37,958,004	$19,882,764	$13,434	$7,828,002	**$72,237,753**
KENTUCKY	$4,024,566	$4,024,566	$627,900	-	-	**$5,912,962**
MICHIGAN	$14,394,240	$14,394,240	$1,616,159	$18,768	-	**$19,035,964**
MINNESOTA	$230,036,625	$230,036,625	$12,732,225	$683,100	-	**$280,863,825**
MISSOURI	$15,506,618	$15,506,618	$831,726	-	-	**$22,012,868**
MONTANA	$2,745,913	$2,745,913	$54,209,988	$13,402,670	-	**$70,358,571**
NEBRASKA	$107,575,776	$107,575,776	$2,124,390	-	$508,200	**$123,923,976**
NORTH DAKOTA	$116,347,493	$116,347,493	$109,259,568	$17,552,938	-	**$285,596,546**
OHIO	$48,452,897	$48,452,897	$3,278,231	-	-	**$67,046,109**
SOUTH DAKOTA	$121,378,673	$121,378,673	$14,384,991	$65,130	$2,184,126	**$160,744,874**
UTAH	-	-	$728,640	$282,900	-	**$1,011,540**
WISCONSIN	$24,739,344	$24,739,344	$930,010	$8,197	-	**$29,188,415**
WYOMING	-	-	$371,450	$1,240,620	-	**$1,612,070**

Table 6: Calculated annual losses due to congested freight environment for corn, soybeans, wheat, barley, and sorghum combined

COMBINED ANNUAL LOSS ESTIMATES

	Combined Losses **Low**	Combined Losses High	Number Of Farming Operations	Average Loss Per Farming Operation
COLORADO	$3,217,500	**$8,222,500**	38,800	$147
IDAHO	$5,167,589	**$13,052,097**	24,600	$370
ILLINOIS	$78,114,596	**$182,545,219**	70,700	$1,843
INDIANA	$30,464,936	**$71,192,937**	56,000	$908
IOWA	$41,086,443	**$95,868,366**	85,300	$803
KANSAS	$30,217,564	**$72,237,753**	58,500	$876
KENTUCKY	$2,510,726	**$5,912,962**	74,800	$56
MICHIGAN	$8,097,341	**$19,035,964**	44,300	$306
MINNESOTA	$113,601,413	**$280,863,825**	68,000	$2,900
MISSOURI	$9,403,090	**$22,012,868**	95,200	$165
MONTANA	$27,568,568	**$70,358,571**	26,800	$1,827
NEBRASKA	$53,031,106	**$123,923,976**	45,700	$1,936
NORTH DAKOTA	$114,004,282	**$285,596,546**	26,100	$7,655
OHIO	$28,611,877	**$67,046,109**	77,800	$615
SOUTH DAKOTA	$64,929,075	**$160,744,874**	29,600	$3,812
UTAH	$395,820	**$1,011,540**	17,800	$40
WISCONSIN	$12,474,356	**$29,188,415**	64,100	$325
WYOMING	$630,810	**$1,612,070**	12,000	$93

The per-bushel loss estimates calculated by the USDA in 2015 remain a solid proxy for losses that might occur in 2023. While inflation has driven up the prices for just about everything – from fuel and freight, to retail goods, to grain commodities themselves, the mechanism of how grain shippers' basis bids pass freight costs back to farmers has remained unchanged over time. Basis bids are not considered to be a function of the underlying grain price, so although corn, for instance, may be worth $6.50 per bushel in January 2023, compared to a price tag of only $4.00 per bushel in January 2014, the basis offset should remain static if all other things were equal, varying only with availability of rail freight capacity and competition for scarce rail cars.

Further, when estimating the total potential losses likely to be experienced by agricultural producers in 2023, it is more appropriate to use the 'high' range of estimates rather than the 'low' range in calculating potential per-bushel losses. For one thing, relatively higher fuel costs will drive up the fuel surcharges included in rail freight and exacerbate the weakness in grain basis bids. More importantly, the volume of grain and other agricultural commodities that are produced in the United States and that need to be shipped by a more-burdened rail system have increased, driving up the stakes for receiving reliable transportation. Service losses and volatility in freight prices can be confidently predicted to be worse in 2023 than in 2013-2014 if the rail network becomes congested with DAPL-displaced oil again in the current freight environment.

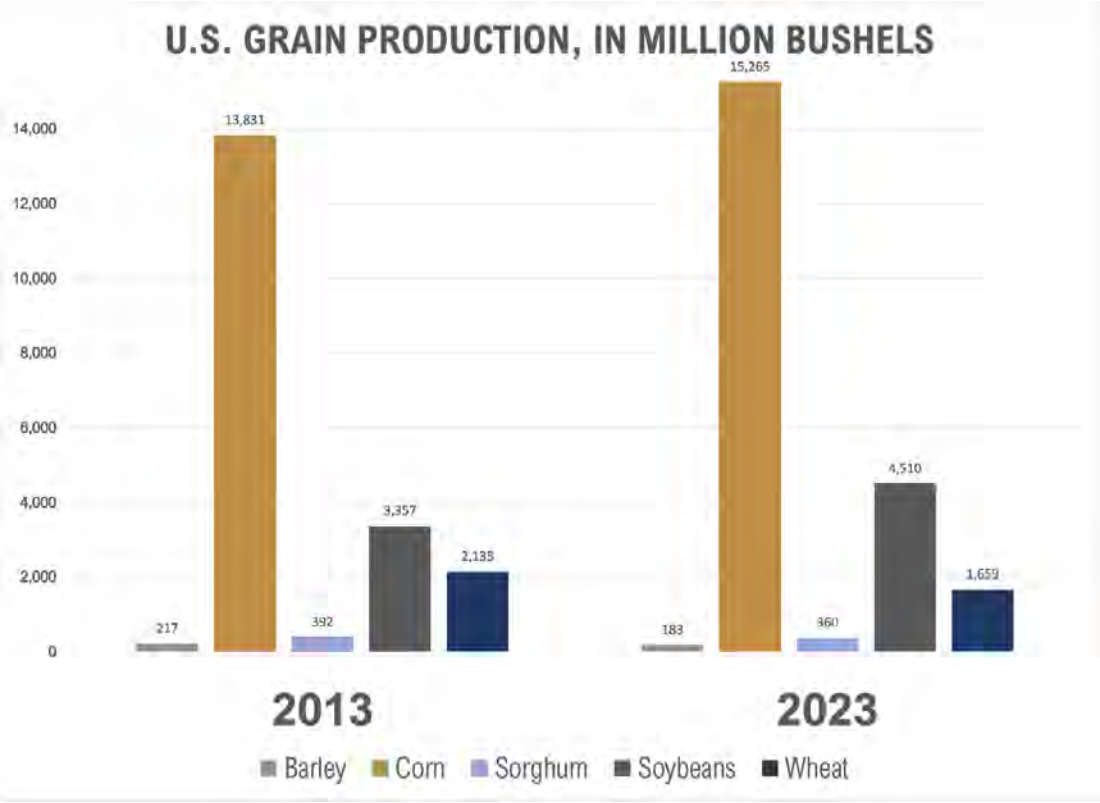


Figure 8: Combined production volumes for barley, corn, sorghum, soybeans, and wheat are projected to be 10% larger in 2023 (21.977 billion bushels) than the combined 2013 production (19.932 billion bushels)

Source: Elaine Kub analysis of NASS data[37,38]

37 USDA National Agricultural Statistics Service https://www.nass.usda.gov/Data_and_Statistics/index.php.

38 USDA Office of the Chief Economist https://www.usda.gov/oce/commodity/wasde/wasde0523.pdf.

Agricultural Inputs (fertilizer, herbicides, etc.)

The agriculture industry relies on a robust supply chain not only to transport its products from distant origins to global destinations, but also to bring necessary goods to the often-rural regions where agricultural production takes place. Table 12 shows the volume of ag inputs shipped by rail in the U.S. in 2021. Note that this list includes farm-specific inputs but not many of the other products necessary for agricultural production – like gravel, steel, concrete, or tires – which also ship to rural locations by rail, but which aren't unique to agriculture.

Table 7: Quantity of farm inputs shipped by rail in 2021, in tons

Source data: Elaine Kub analysis of NASS data. Surface Transportation Board's Carload Waybill Sample, agtransport.usda.gov

1,762,692	Nitrogen fertilizer solution or superphosphate solution
778,090	Ashes (i.e. potash fertilizer)
525,901	Miscellaneous fertilizer compounds
362,278	Anhydrous ammonia
260,541	Potassium alkalies
217,915	Gypsum products
102,130	Agricultural chemicals (fungicides, herbicides, insecticides)
50,432	Agricultural limestone, broken or crushed
11,024	Wheel tractors, parts or attachments
4,412	Other fertilizers
289	Other farm machinery or equipment

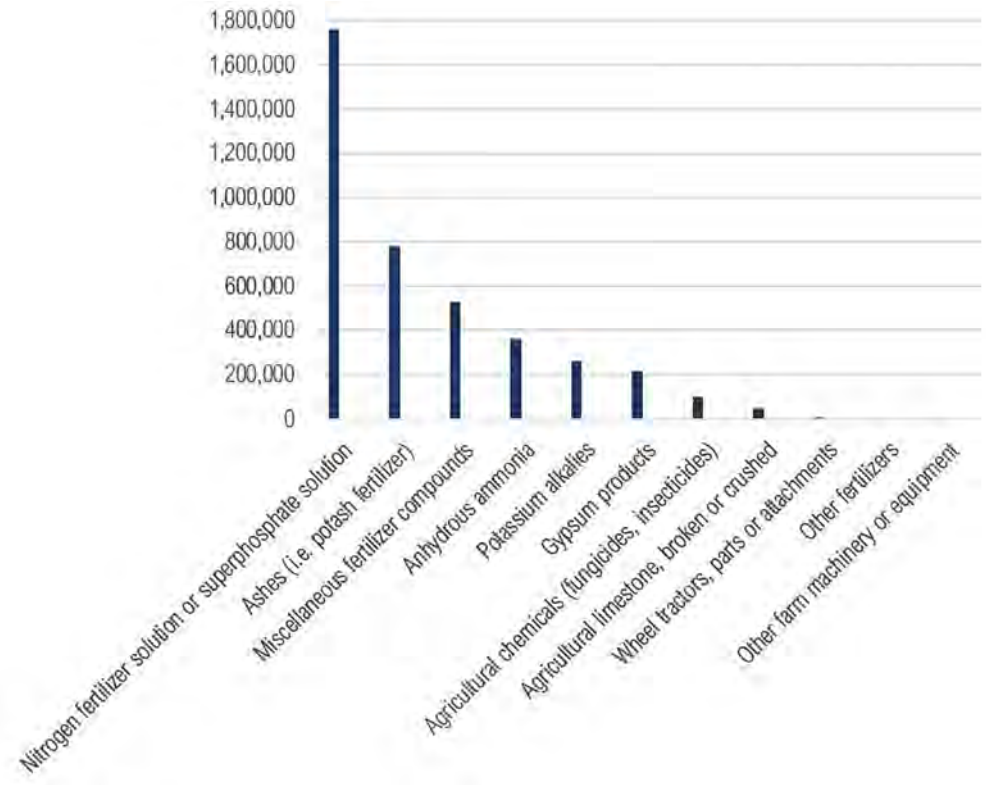


Figure 9: Quantity of farm inputs shipped by rail in 2021, in tons

Source data: Elaine Kub analysis of NASS data. Surface Transportation Board's Carload Waybill Sample, agtransport.usda.gov

On average, freight costs for agricultural inputs dropped $26 per ton in the post-DAPL freight scenario compared to the pre-DAPL freight congestion.[39] However, freight rates vary greatly for this sector of goods – it's quite different to ship bulk dry fertilizer pellets in a hopper car versus farm machinery on a flatbed railcar.

Table 8: Freight costs per ton for agricultural input categories

Source data: Elaine Kub analysis of Surface Transportation Board's Carload Waybill Sample, agtransport.usda.gov

	Pre-DAPL	Post-DAPL
Agricultural Chemicals: Fungicides, Insecticides, Herbicides or Plant Hormones	$3,537	$3,750
Agricultural Limestone, Broken or Crushed	$771	$304
Anhydrous Ammonia	$5,272	$5,034
Ashes	$465	$586
Other Farm Machinery or Equipment	$4,701	$5,871
Other Fertilizers	$5,088	$5,191
Gypsum Products	$102	$80
Harvesting or Hay Parts	$11,978	$8,474
Miscellaneous Fertilizer Compounds	$3,331	$2,786
Potassium Alkalies	$2,602	$2,317
Superphosphate Solution or Nitrogen Fertilizer Solution	$500	$453
Wheel Tractors, Parts or Attachments	$9,670	$9,470
	$876	**$851**

Therefore, in order to estimate the economic impact to the agriculture industry from increased freight costs in a flow shift condition, this analysis collected recent (2021) volumes of ag inputs shipped by rail to certain terminal destinations, filtered using the BEA areas. Note that the BEA areas do not align with state borders in all cases. A conservative assumption was made that in a potential 2023 freight congestion scenario, the freight costs for this class of freight would increase, on average, $26 per ton, as it did in the congested 2013-14 condition. In reality, freight congestion may be even more severe in 2023 if a flow shift causes congestion on a more-burdened rail system. In May 2023, the volume of fertilizer being shipped by rail has surged to an all-time high of 6,550 carloads per week.[40] In the event of sudden congestion, ag input freight could easily rise even more than $26 per ton. Notably, the freight rate for nitrogen fertilizer, the most important ag input shipped by rail and the one shipped at the highest volume, fell almost $50 per ton after the 2013-14 congestion was relieved.

39 Public Use Carload Waybill Sample https://www.stb.gov/reports-data/waybill/.

40 Seasonal Originated Fertilizer Carloads https://agtransport.usda.gov/Rail/Seasonal-Originated-Fertilizer-Carloads/bpst-47qp.

Table 9: State-by-state estimates of increased farm input shipping expenses

Source data: Elaine Kub analysis of Surface Transportation Board's Carload Waybill Sample, agtransport.usda.gov

	Tons of Farm Inputs **Shipped by Rail,** Terminating in States' **BEAs - 2021**	Additional Freight Costs per Ton	Estimated Additional Farm Input Shipping Expenses
COLORADO	108,871	$26	**$2,830,646**
IDAHO	39,157	$26	**$1,018,082**
ILLINOIS	517,943	$26	**$13,466,518**
INDIANA	45,504	$26	**$1,183,104**
IOWA	134,970	$26	**$3,509,220**
KANSAS	23,513	$26	**$611,338**
KENTUCKY	8,697	$26	**$226,122**
MICHIGAN	3,996	$26	**$103,896**
MINNESOTA	255,409	$26	**$6,640,634**
MISSOURI	74,548	$26	**$1,938,248**
MONTANA	23,515	$26	**$611,390**
NEBRASKA	143,002	$26	**$3,718,052**
NORTH DAKOTA	168,374	$26	**$4,377,724**
OHIO	12,040	$26	**$313,040**
SOUTH DAKOTA	91,233	$26	**$2,372,058**
UTAH	11,364	$26	**$295,464**
WISCONSIN	3,595	$26	**$93,470**
WYOMING	82,318	$26	**$2,140,268**

Economic Implications for Processors of Agricultural Commodities

For grain bushels that get exported, freight congestion's costs to the U.S. agriculture industry may end as soon as a shipper has paid the excess freight and passed back that loss to farmers in the form of weaker basis bids. But for the majority of grain bushels which remain within this country, there are additional increased costs as a result of rail congestion. For instance, over 50% of the soybeans used in America[41] are crushed domestically into soybean meal and soybean oil. When the nation's rail system becomes congested and unreliable, the plants which do this processing activity then face the very same problem that farmers and grain shippers originally faced — trying to get timely rail service and paying increased freight charges for whichever trains are available. **Oil flows shifted from DAPL would compete directly with these processors for rail freight service.**

For the processors of liquid ag commodities and perishable livestock feed, there is an additional concern. If an ethanol plant doesn't receive rail service on time, it can only produce ethanol until its available storage capacity is met. Bottlenecked without a freight outlet, the ethanol plant will have to shut down production.

If an ethanol plant doesn't receive rail service on time, it can only produce ethanol until its available storage capacity is met. Bottlenecked without a freight outlet, the ethanol plant will have to shut down production.

Indeed, this is what happened in the pre-DAPL congested freight scenario of 2013-14. Nationwide **ethanol production decreases "amounted to 80,000 barrels per day between December 2013 and March 2014" during the pre-DAPL freight congestion**, according to Renewable Fuels Association President Bob Dineen[42] at the time. 80,000 barrels per day equated to 9% of lost production at that time when nationwide ethanol production ranged between 868 and 944 thousand barrels per day, averaging 904,000 barrels per day between December 2013 and March 2014.[43]

This analysis draws on that historical observation to estimate annual production and economic losses using the higher state-by-state ethanol production volumes seen today. Economic losses suffered by ag processors would come from two directions: the processors would pay more (higher freight costs for the portion of their production that gets shipped by rail) and at the same time they would earn less (lost production when poor rail service means they cannot move or store value-added ag commodities, so they must shut down production).

41 USDA Office of the Chief Economist https://www.usda.gov/oce/commodity/wasde/wasde0523.pdf.
42 Rail Delays Hitting Home for Ethanol, Grain Shippers https://www.farmprogress.com/farm-business/rail-delays-hitting-home-for-ethanol-grain-shippers.
43 Elaine Kub analysis of Weekly Ethanol Production https://www.eia.gov/dnav/pet/pet_pnp_wprode_s1_w.htm.

Table 10: Tons of processed ag commodities produced and shipped by rail

	U.S. Annual Production in Tons	U.S. Annual Quantity Shipped By Rail[44] in Tons	Percent of Production Reliant on Rail Service
SOYBEAN MEAL[45]	52,539,000	4,325,336	8%
ETHANOL[46]	50,743,000	12,009,798	24%
DDGS (ETHANOL CO-PRODUCT LIVESTOCK FEED)	46,200,000	3,017,616	7%
WHEAT FLOUR[47]	21,514,200	1,445,843	7%
SOYBEAN OIL	13,097,500	1,284,141	10%

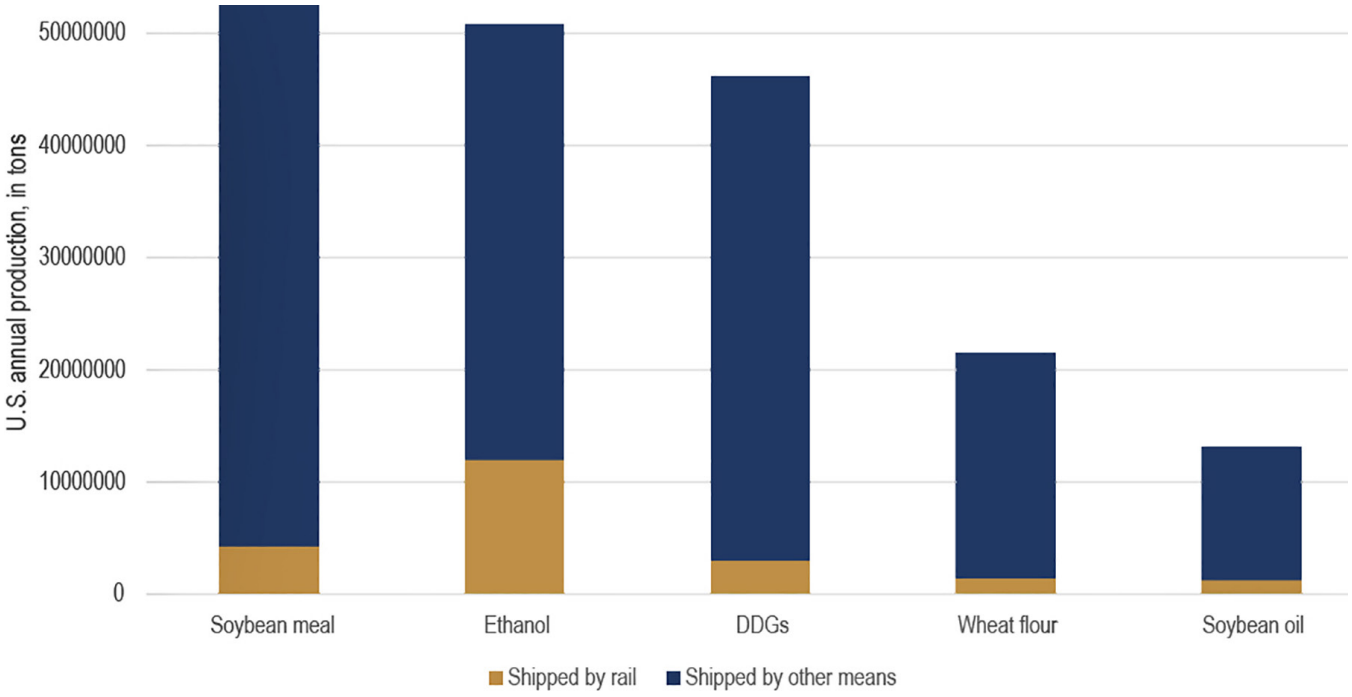


Figure 10: Percent of processed ag commodity production reliant on rail service

44 Elaine Kub analysis of https://agtransport.usda.gov/Rail/Public-Use-Carload-Waybill-Sample/xve5-xb56.
45 Oil Crops Yearbook https://www.ers.usda.gov/data-products/oil-crops-yearbook/.
46 Most U.S. Fuel Ethanol Production Capacity https://www.eia.gov/todayinenergy/detail.php?id=53539.
47 https://www.bakingbusiness.com/articles/58318-flour-production-reaches-a-new-record-in-2022.

Table 11: Processed ag commodities shipped by rail, 2021, actual weight in tons[48]

Source data: Elaine Kub analysis of Surface Transportation Board's Carload Waybill Sample, agtransport.usda.gov

	Colorado	Illinois	Indiana	Iowa	Kansas	Minnesota	Missouri	Nebraska	North Dakota	Ohio	South Dakota	Wisconsin
Ethanol	3,045	1,604,023	40,950	2,421,816	184,162	847,586	3,410	1,604,986	395,462	1,624	677,932	122,310
Ethanol By-Products	-	-	30,331	208,671	-	153,485	-	17,060	208,207	6,169	164,143	-
Corn Meal or Flour	-	2,135	-	-	-	-	6,340	-	-	-	-	-
Corn Oil	-	4,694	-	16,040	-	-	-	11,953	-	-	3,131	-
Corn Starch	-	9,506	2,765	-	-	-	-	-	-	-	-	-
Corn Syrup	-	123,335	-	31,536	-	-	-	180,537	-	-	-	-
Distilled, Rectified or Blended Liquors	-	5,624	-	-	-	-	2,361	-	-	-	-	-
Fatty Acids	-	-	-	14,462	-	-	-	-	-	-	-	-
Other Flour or other Grain Products	-	23,920	3,053	6,115	-	-	-	4,297	1,718	-	-	-
Nut or Vegetable Oils	-	25,263	-	-	-	-	-	-	-	-	-	-
Malt Extracts or Brewers Spent Grains	-	-	-	53,364	-	-	-	-	-	-	-	-
Prepared Feed, Animal, Fish or Poultry	-	378,904	-	704,341	-	-	205,141	493,575	-	-	-	-
Soybean Cake, Flour, Grits, Meal or other By-Products	-	338,055	4,251	196,559	-	130,068	197,701	453,197	-	-	-	-
Soybean Oil, Crude or Refined	-	15,067	1,244	29,597	-	31,704	12,532	13,802	-	-	-	-
Wet Process Corn or Lar Mill Byproducts	-	-	-	2,548	-	-	-	6,829	-	-	-	-
Other Sugar Mill Products or Byproducts	-	-	-	-	-	-	-	-	7,558	-	-	-
Sugar Molasses	-	-	-	-	-	-	-	-	2,733	-	-	-
Sugar, Granulated or Powdered, Sugar Cubes or Tablets	2,021	11,986	-	-	-	9,039	-	-	25,594	-	-	-
Wheat Flour	-	21,210	-	-	12,098	9,640	7,475	958	-	-	-	-

48 Elaine Kub analysis of https://agtransport.usda.gov/Rail/Public-Use-Carload-Waybill-Sample/xve5-xb56.

Ethanol Plants

Annual U.S. rail carloads of ethanol reached 438,199 in 2021, a 40% increase over 2014 levels.[49] The scale of disruption to the ethanol industry would therefore likely be considerably worse today if 2014-levels of congested rail service occurred in 2023.

Table 12: U.S. ethanol plants, capacity, and production 1999-2021

Source data: https://afdc.energy.gov/data/10342, eia.gov/petroleum/ethanolcapacity/index.php, eia.gov/totalenergy/data/monthly/#renewable, https://anolrfa.org

Year	Ethanol Plants	Capacity (BGY)	Production (BGY)	Production as % of Capacity
1999	50	1.779	1.465	82%
2000	54	1.840	1.622	88%
2001	56	2.007	1.765	88%
2002	61	2.738	2.140	78%
2003	68	3.190	2.810	88%
2004	72	3.699	3.404	92%
2005	81	4.398	3.904	89%
2006	95	6.317	4.884	77%
2007	110	11.623	6.521	56%
2008	139	13.424	9.309	69%
2009	170	14.541	10.938	75%
2010	193	13.614	13.298	98%
2011	194	13.728	13.929	101%
2012	193	13.852	13.218	95%
2013	187	13.681	13.293	97%
2014	195	14.369	14.313	100%
2015	195	14.903	14.807	99%
2016	198	15.505	15.413	99%
2017	200	16.288	15.936	98%
2018	200	16.868	16.061	95%
2019	201	17.378	15.776	91%
2020	197	17.546	13.926	79%
2021	192	17.380	15.016	86%

Notes: Prior to 2010, plant and capacity data were retrieved from the RFA. Starting in 2010, plant and capacity data were retrieved from EIA U.S. Fuel Ethanol Plan Production Capacity. Production data are retrieved from EIA Monthly Energy Review. Number of plants and total capacity are listed as of the end of the posted year. This causes the production/capacity ratio to look falsely low because plants built late in the year count 100% to capacity but only partially to production.
BGY: Billion gallons of ethanol per year
Last updated December 2022

49 https://agtransport.usda.gov/Rail/Annual-U-S-Rail-Carloads-of-Ethanol/sgce-bw6d.

Analysis of STB waybill data shows that the most common origin of rail-shipped ethanol is Iowa (BEA origins 100, 103, and 117 — see Appendix A), and the most common route for ethanol-by-rail coming out of Iowa is toward Chicago, using the same route, same cars, same locomotives, same crew as Bakken oil trains would use. Further north along the same rail routes that would need to serve shifted DAPL oil flows, the most common destinations for ethanol coming out of South Dakota or North Dakota include California, the Pacific Northwest, or Texas.

For a full list of ethanol plants with their present capacities and locations, see Appendix B: Full List of U.S. Ethanol Plants by State.

Table 13: State-by-state ethanol production.
Source: Elaine Kub analysis of U.S. Energy Information Administration data

State By State Ethanol Production in 2023, Assuming 100% of Capacity	
COLORADO	461,100 tons per year
IDAHO	197,614 tons per year
ILLINOIS	5,740,695 tons per year
INDIANA	4,331,046 tons per year
IOWA	15,460,024 tons per year
KANSAS	1,979,436 tons per year
KENTUCKY	174,559 tons per year
MICHIGAN	1,274,612 tons per year
MINNESOTA	4,690,046 tons per year
MISSOURI	1,090,172 tons per year
NEBRASKA	7,390,774 tons per year
NORTH DAKOTA	1,801,584 tons per year
OHIO	2,377,959 tons per year
SOUTH DAKOTA	4,755,917 tons per year
WISCONSIN	1,976,143 tons per year

In the event of a shift of flows from DAPL to Midwest rail systems and associated freight congestion, the economic losses to the ethanol industry would come from two sources: increased costs from higher freight prices and losses from necessary production shutdowns. The scale of potentially higher freight costs in 2023 can be estimated by comparing the ethanol freight costs during the 2013-14 congested freight scenario to the post-DAPL relieved freight scenario, then applying those increases to the present-day volumes of ethanol which ship by rail from each state. Freight costs for ethanol shipped by rail fell an average of $39.90 per ton in the post-DAPL scenario compared to the pre-DAPL congested scenario.

Table 14: Ethanol freight costs per ton, 2005-2021

Source data: Elaine Kub analysis of STB waybill data

	Ethanol Shipped by Rail - Sum of Billed Weight in Tons	Freight Revenue	Freight Cost per Ton
2005	577,741	$437,324,688	$756.96
2006	898,959	$625,060,526	$695.32
2007	1,576,615	$859,698,760	$545.28
2008	2,928,280	$1,321,092,216	$451.15
2009	5,022,256	$1,499,412,734	$298.55
2010	6,845,915	$1,820,012,708	$265.85
2011	7,649,999	$1,993,947,499	$260.65
2012	7,044,997	$1,808,571,995	$256.72
2013	7,579,311	$1,848,536,252	$243.89
2014	8,432,371	$1,987,557,161	$235.71
2015	10,904,142	$2,135,058,575	$195.80
2016	10,461,032	$2,091,005,875	$199.89
2017	11,345,513	$2,237,892,090	$197.25
2018	12,601,309	$2,374,246,452	$188.41
2019	11,991,627	$2,357,466,912	$196.59
2020	10,660,113	$2,178,890,939	$204.40
2021	14,233,376	$2,465,088,090	$173.19

Table 15: State-by-state estimated additional ethanol shipping expenses in a freight-congested environment at 2023 volumes

Source: Elaine Kub analysis of EIA data and STB waybill data

	Projected 2023 Ethanol Production in Tons	Historical Annual Statewide Ethanol Production in Tons	Historical Annual Rail[50] Shipments of Alcohol in Tons	Historical % Shipped by Rail	Additional Rail Freight Costs per Ton	Estimated Additional Ethanol Shipping Expenses
COLORADO	461,100	364,269	3,045	0.8%	$39.90	**$153,792**
IDAHO	197,614	156,115	-	-	$39.90	-
ILLINOIS	5,740,695	4,676,522	1,604,023	34.3%	$39.90	**$78,564,247**
INDIANA	4,331,046	3,201,368	40,950	1.3%	$39.90	**$2,210,467**
IOWA	15,460,024	12,745,311	2,421,816	19.0%	$39.90	**$117,212,454**
KANSAS	1,979,436	1,759,696	184,162	10.5%	$39.90	**$8,265,645**
KENTUCKY	174,559	137,901	-	-	$39.90	-
MICHIGAN	1,274,612	1,021,013	-	-	$39.90	-
MINNESOTA	4,690,046	3,774,196	847,586	22.5%	$39.90	**$42,025,158**
MISSOURI	1,090,172	843,536	3,410	0.4%	$39.90	**$175,840**
NEBRASKA	7,390,774	5,929,239	1,604,986	27.1%	$39.90	**$79,824,301**
NORTH DAKOTA	1,801,584	1,698,692	395,462	23.3%	$39.90	**$16,734,681**
OHIO	2,377,959	1,760,249	1,624	0.1%	$39.90	**$87,536**
SOUTH DAKOTA	4,755,917	3,826,761	677,932	17.7%	$39.90	**$33,617,231**
WISCONSIN	1,976,143	1,520,247	122,310	8.0%	$39.90	**$6,343,649**

50 Elaine Kub analysis of https://agtransport.usda.gov/Rail/Public-Use-Carload-Waybill-Sample/xve5-xb56

The second set of losses would be experienced by the ethanol industry if freight congestion causes individual plants to shut down production. As a reminder, if an ethanol plant cannot receive rail service in a timely manner, and has already met its available storage capacity, it may have to shut down production and forgo its expected profit margin on the lost volume of business. Calculating the scale of such losses industry-wide requires making two critical assumptions.

First of all, how much production would be cut if freight service for ethanol tanker cars became unreliable in a congested-freight environment? For this analysis, it was assumed the industry would have to cut 9% of its expected annual production, in line with the cuts seen in late 2013 and early 2014 during the pre-DAPL freight congestion.

Second, how much profit margin would be lost for each gallon the ethanol plants are unable to produce? The plants would lose the opportunity to sell each gallon of ethanol they couldn't ship, but they would also lose the opportunity to sell the associated co-products (e.g. distillers grains, a common livestock feed product) that would never be made because each original bushel of corn feedstock would never be processed. In early 2023, an average industry expectation for ethanol crush margins would be to produce 2.8 gallons of ethanol and 18 pounds of distillers grains from each bushel of corn processed by an ethanol plant. Wholesale ethanol at $2.22 per gallon[51] therefore contributes $6.22 of revenue for each bushel of corn processed, and distillers grains worth $290 per ton contribute $2.61 of revenue for each bushel of corn processed. The combined value of the crush products reaches $8.83 for each bushel of corn processed. The input cost for each bushel of corn during this timeframe would average $6.70.[52] Therefore, the gross profit margin for each bushel of corn processed by an average U.S. ethanol plant in early 2023 should be assumed at $2.13. This gross profit margin figure doesn't include additional overhead expenses involved in the operation of the plant, because the plant will still be running, and it is instead the marginal loss of the 9% production cuts which are being calculated. By still operating the ethanol plant, but simply purchasing fewer bushels of corn and producing fewer gallons of ethanol and fewer tons of DDGs, the ethanol plant forgoes the opportunity to see $2.13 per bushel gross profit ($8.83 of crush products never sold netted against $6.70 of corn never purchased.)

Each gallon of ethanol not produced due to freight congestion accounts for 36% of the lost profit margin from each corn bushel not processed (1 bushel ÷ 2.8 gallons per bushel). This analysis assumes that each gallon of lost ethanol production is equivalent to $0.76 of lost crush margin ($2.13 gross per bushel ÷ 2.8 gallons per bushel). These cumulative losses are then calculated for each ethanol-producing state.

51 USDA AMS Livestock, Poultry & Grain Market News, January 13 2023 National Weekly Ethanol Report https://mymarketnews.ams.usda.gov/filerepo/sites/default/files/3616/2023-01-09/668861/ams_3616_00026.pdf.

52 USDA AMS Livestock, Poultry & Grain Market News, January 13 2023 National Weekly Ethanol Report https://mymarketnews.ams.usda.gov/filerepo/sites/default/files/3616/2023-01-09/668861/ams_3616_00026.pdf.

Table 16: Estimated ethanol industry losses due to lost production in a congested-freight environment, assuming 9% production cuts from original expected 2023 production, 303.63 gallons per short ton of ethanol, and $0.76 per gallon lost

Source: Elaine Kub analysis

	Estimated Lost Production (Tons) If Congestion Lasts 1 Year	Estimated Lost Production (Gallons) If Congestion Lasts 1 Year	Estimated Lost Profit Opportunity If Congestion Lasts 1 Year
COLORADO	40,805	12,389,716	**$9,416,184**
IDAHO	17,488	5,309,871	**$4,035,502**
ILLINOIS	508,026	154,251,967	**$117,231,495**
INDIANA	383,278	116,374,823	**$88,444,865**
IOWA	1,368,144	415,409,477	**$315,711,202**
KANSAS	175,171	53,187,270	**$40,422,325**
KENTUCKY	15,448	4,690,385	**$3,564,693**
MICHIGAN	112,798	34,248,712	**$26,029,021**
MINNESOTA	415,048	126,021,121	**$95,776,052**
MISSOURI	96,475	29,292,825	**$22,262,547**
NEBRASKA	654,051	198,589,443	**$150,927,977**
NORTH DAKOTA	159,432	48,408,403	**$36,790,386**
OHIO	210,439	63,895,548	**$48,560,616**
SOUTH DAKOTA	420,878	127,791,069	**$97,121,212**
WISCONSIN	174,880	53,098,788	**$40,355,079**

Overall, the combined losses to the ethanol industry, including both the increased freight expenses, plus the lost profit opportunity due to production shutdowns, could reach approximately $1.5 billion.

Table 17: Estimated annual losses to the ethanol industry in a congested-freight environment

Source: Elaine Kub analysis

	Estimated Additional Ethanol Shipping Expenses	Estimated Lost Profit Opportunity If Congestion Lasts 1 Year	Estimated Ethanol Industry Losses
COLORADO	$153,792	$9,416,184	**$9,569,976**
IDAHO	-	$4,035,502	**$4,035,502**
ILLINOIS	$78,564,247	$117,231,495	**$195,795,741**
INDIANA	$2,210,467	$88,444,865	**$90,655,332**
IOWA	$117,212,454	$315,711,202	**$432,923,656**
KANSAS	$8,265,645	$40,422,325	**$48,687,970**
KENTUCKY	-	$3,564,693	**$3,564,693**
MICHIGAN	-	$26,029,021	**$26,029,021**
MINNESOTA	$42,025,158	$95,776,052	**$137,801,210**
MISSOURI	$175,840	$22,262,547	**$22,438,387**
NEBRASKA	$79,824,301	$150,927,977	**$230,752,278**
NORTH DAKOTA	$16,734,681	$36,790,386	**$53,525,067**
OHIO	$87,536	$48,560,616	**$48,648,153**
SOUTH DAKOTA	$33,617,231	$97,121,212	**$130,738,444**
WISCONSIN	$6,343,649	$40,355,079	**$46,698,728**
TOTAL			**$1,481,864,158**

Other Grain Processing

Although state-by-state information about production volumes aren't available for the nation's soybean meal, soybean oil, and other oilseed crush products, and although the rail shipping volume of these products is outweighed by the scale of ethanol shipments, for each individual grain processor that relies on rail freight, the availability of uncongested rail service remains an important concern. Grain processors not only pay higher input costs when poor rail service and high freight costs drive up the prices of grain at these destinations, but they also experience higher freight costs when shipping their own value-added products out from the processing plant by rail.

Geographically, the production and shipment of soybean meal and soybean oil tends to be focused in the Midwest and states farther east.[53] Other types of grain processors which would be equally interested in keeping the nation's rail network free of congestion include cottonseed oil producers, located primarily in the southern United States, and any other business dependent on shipping or receiving animal feed. Many specialty crops such as sunflower seed, canola, and flaxseed — as well as sugarbeets and their processed sugar — are produced primarily in North Dakota, where rail congestion in the pre-DAPL 2013-14 scenario was particularly severe.

Wheat flour milling operations are not necessarily located near the origin of the wheat and are often closer to the final customers in larger population centers. They are therefore dependent on efficient rail service uninterrupted by congestion to receive grain. A few major wheat-producing states are among the top five rail shippers of wheat flour.

Table 18: Wheat flour shipped by rail, 2021, in tons
Source: STB waybill data

	Wheat Flour shipped by rail, 2021, in tons
ILLINOIS	21,210
KANSAS	12,098
MINNESOTA	9,640
MISSOURI	7,475
NEBRASKA	958

Projections for a significant increase in renewable diesel production in the United States in coming years[54] present a particularly thorny concern for the agricultural industry if DAPL oil flows shift to the rail system and freight congestion once again occurs. It is reasonable to expect that the already short supply of tanker cars may become more constrained if oil flows shift to the rail system. *Biodiesel Magazine* maintains a list of all the operational, under-construction, and proposed biodiesel plants in the U.S. at https://biodieselmagazine.com/plants/listplants/USA/construction/.

If all the plants listed there reach their capacity, nationwide production will reach 7.5 billion gallons per year,[55] drastically altering the freight competition for soybean oil and other edible oils to move in nontraditional routes toward these renewable diesel plants and, of course, for the finished diesel to move by rail from these plants. Not only will these movements create congestion on the railways, but they will also create additional competition for (and increase costs) for the already-scarce supply of DOT-approved tanker cars.

53 Soybean Meal Info Center https://www.soymeal.org/processors/.
54 https://farmdocdaily.illinois.edu/2023/02/overview-of-the-production-capacity-of-u-s-biodiesel-plants.html.
55 https://www.dtnpf.com/agriculture/web/ag/news/article/2023/04/19/looming-renewable-diesel-revolution.

Conclusions

In the event of a shift in DAPL oil flows to Midwest rail systems, overall losses to the agriculture industry would accumulate to more than $3 billion. This shift would cause rail freight congestion like that seen in 2013-2014, but would have a greater impact as a result of the higher volumes of commodity shipment anticipated in 2023. Certain states would be most affected by this congestion, namely the Upper Midwest states that are heavily reliant on rail for shipping grain long distances (and which share DAPL's route for oil moving from North Dakota to Illinois), but also the states in the heart of the Corn Belt where large volumes of ag processing take place.

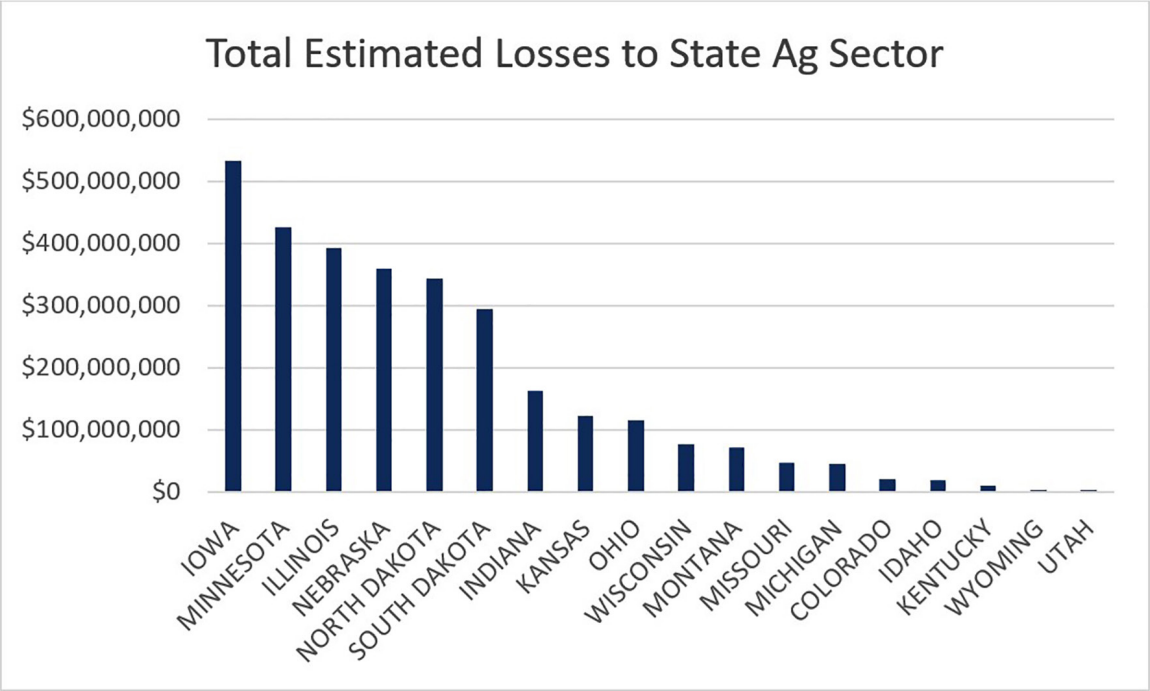


Figure 11: Total estimated statewide ag industry losses due to freight congestion, annual

Freight costs passed back to farmers at the same scale seen in 2014 ($0.42 per bushel of corn or sorghum shipped by rail, $0.27 per bushel of soybeans, $0.46 per bushel of wheat or barley), may lead to **$1.51 billion in annual losses out of farmers' pockets.**

Increased freight costs and a loss of 9% of 2023 ethanol production may lead to **$1.48 billion in annual losses to the ethanol industry.**

Higher freight costs to ship ag inputs by rail may cost ag retailers and farmers **$45 million more to receive their necessary fertilizers and chemicals by rail.**

Table 19: Summary of projected state-by-state losses to the agriculture industry in congested freight environment, annual

	Projected Grain Producers Losses	Projected Ethanol Industry Losses	Projected Ag Inputs	TOTAL ESTIMATED LOSSES TO STATE AG SECTOR
COLORADO	$8,222,500	$9,569,976	$2,830,646	**$20,623,122**
IDAHO	$13,052,097	$4,035,502	$1,018,082	**$18,105,681**
ILLINOIS	$182,545,219	$195,795,741	$13,466,518	**$391,807,478**
INDIANA	$71,192,937	$90,655,332	$1,183,104	**$163,031,372**
IOWA	$95,868,366	$432,923,656	$3,509,220	**$532,301,243**
KANSAS	$72,237,753	$48,687,970	$611,338	**$121,537,062**
KENTUCKY	$5,912,962	$3,564,693	$226,122	**$9,703,776**
MICHIGAN	$19,035,964	$26,029,021	$103,896	**$45,168,881**
MINNESOTA	$280,863,825	$137,801,210	$6,640,634	**$425,305,669**
MISSOURI	$22,012,868	$22,438,387	$1,938,248	**$46,389,503**
MONTANA	$70,358,571	-	$611,390	**$70,969,961**
NEBRASKA	$123,923,976	$230,752,278	$3,718,052	**$358,394,306**
NORTH DAKOTA	$285,596,546	$53,525,067	$4,377,724	**$343,499,337**
OHIO	$67,046,109	$48,648,153	$313,040	**$116,007,302**
SOUTH DAKOTA	$160,744,874	$130,738,444	$2,372,058	**$293,855,376**
UTAH	$1,011,540	-	$295,464	**$1,307,004**
WISCONSIN	$29,188,415	$46,698,728	$93,470	**$75,980,613**
WYOMING	$1,612,070	-	$2,140,268	**$3,752,338**
	$1,510,426,592	**$1,481,864,158**	**$45,449,274**	**$3,037,740,024**

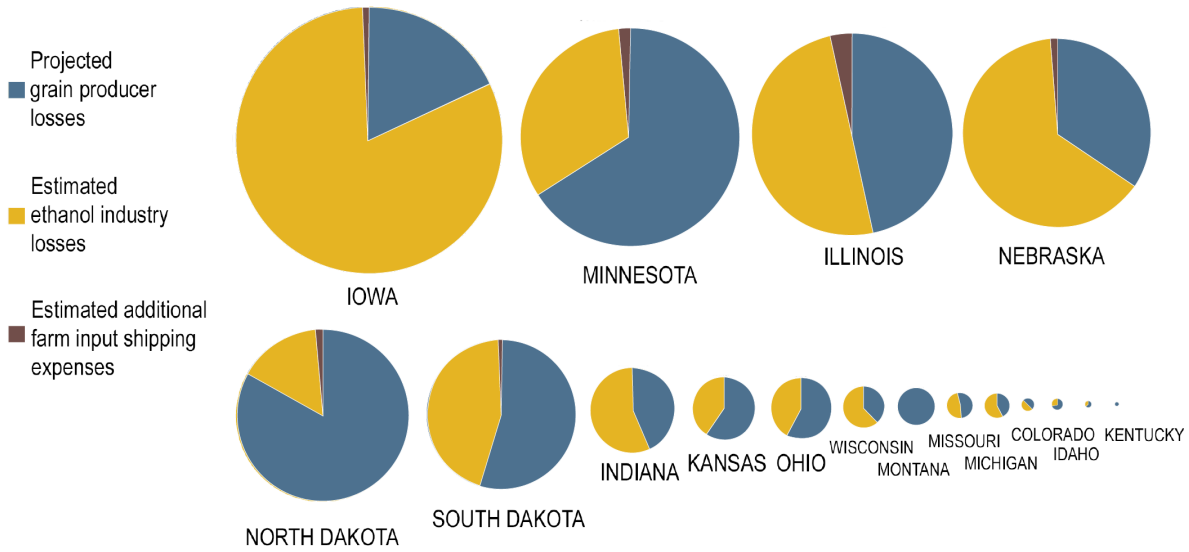


Figure 12: Sources and scale of projected annual state-by-state agriculture industry losses in a freight congested environment

For More Information

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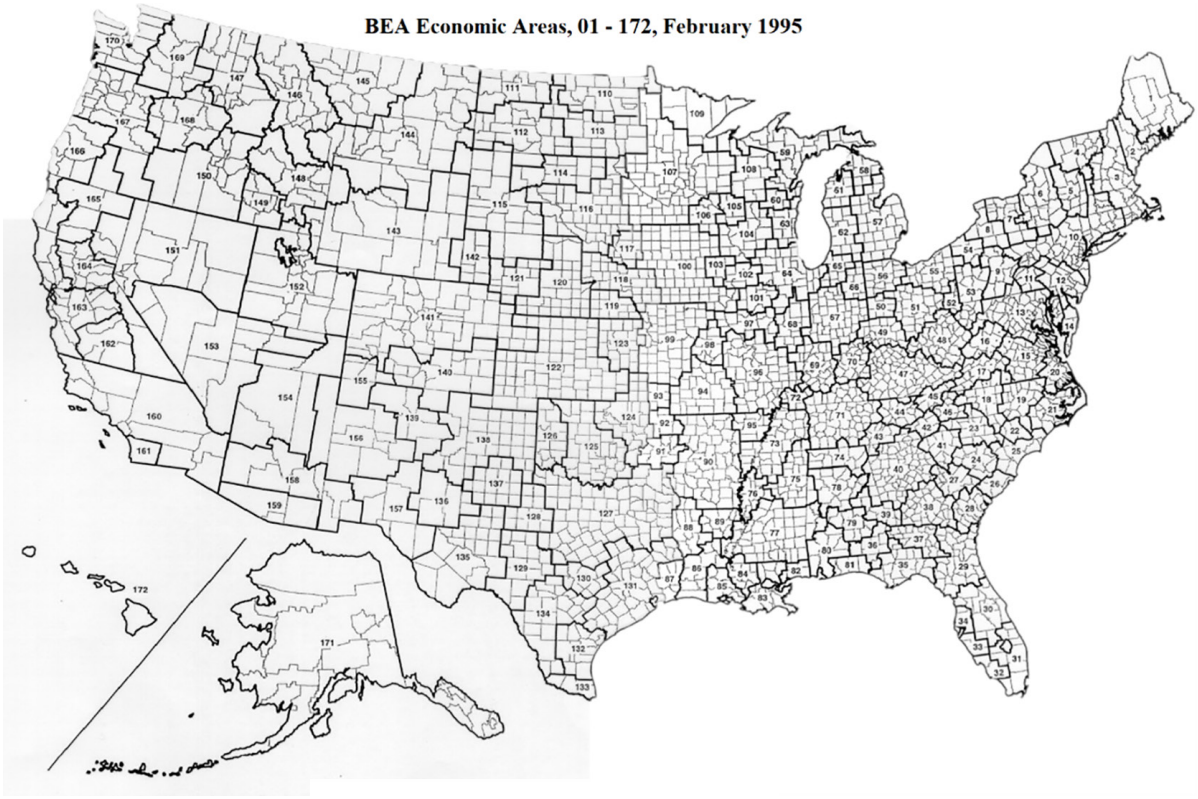
Appendix A:
Business Economic Areas by State

For the purposes of state-by-state analysis of the volumes of agricultural commodities shipped by rail, the following BEA codes, as defined by the U.S. Bureau of Economic Analysis, were determined to represent each state.



Idaho	147, 149, 150
Montana	144, 145, 146, 148
Wyoming	143
Utah	152
Colorado	140, 141
North Dakota	110, 111, 112, 113
South Dakota	114, 115, 116
Nebraska	118, 119, 120, 121, 142
Kansas	122, 123
Minnesota	106, 107, 109
Iowa	100, 103, 117
Missouri	93, 94, 98, 99
Wisconsin	60, 63, 104, 105, 108
Illinois	64, 68, 96, 97, 101, 102
Michigan	57, 58, 59, 61, 62
Indiana	65, 66, 67, 69, 70
Ohio	49, 50, 51, 52, 55, 56
Kentucky	47

See https://www.bts.gov/archive/publications/federal_register/1995/bts_19950310 for a full list of BEA Economic Areas.

Appendix B:
Full List of U.S. Ethanol Plants by State

Original data tracked by the U.S. Energy Information Administration at https://www.eia.gov/petroleum/ethanolcapacity/index.php
State sums and conversions to tons made by Elaine Kub's analysis

U.S. Fuel Ethanol Plant Production Capacity as of January 1, 2022

STATE	RESPONDENT	CITY	MMGAL/ YR	MB/D	STATE SUM (MMGAL/YR)	STATE SUM (TONS PER YEAR)
NEW YORK	Western New York Energy LLC	Medina	62	4	**62**	**204,201**
NORTH CAROLINA	Tyton NC Biofuels LLC	Raeford	57	4	**57**	**187,734**
PENNSYLVANIA	Pennsylvania Grain Prcsg LLC	Clearfield	128	8	**128**	**421,577**
ILLINOIS	Adkins Energy LLC	Lena	60	4	**1,743**	**5,740,695**
	ADM	Decatur	375	24	-	-
	Alto ICP LLC	Pekin	82	5	-	-
	Alto Pekin LLC Wet Mill	Pekin	100	7	-	-
	Alto Pekin LLC Dry Mill	Pekin	53	3	-	-
	Big River Resources Galva LLC	Galva	100	7	-	-
	Biourja Renewables LLC	Peoria	61	4	-	-
	Green Plains Madison LLC	Madison	88	6	-	-
	Illinois River Energy LLC	Rochelle	138	9	-	-
	Lincolnland Agri-Energy LLC	Palestine	66	4	-	-
	Marquis Energy LLC	Hennepin	340	22	-	-
	One Earth Energy LLC	Gibson City	150	10	-	-
	Patriot Renewable Fuels LLC	Annawan	130	8	-	-
INDIANA	Cardinal Ethanol LLC	Union City	133	9	**1,315**	**4,331,046**
	Central Indiana Ethanol LLC	Marion	50	3	-	-
	Grain Processing Corp	Washington	37	2	-	-
	Green Plains Mount Vernon LLC	Mount Vernon	88	6	-	-
	Iroquois Bio-Energy Co LLC	Rensselaer	60	4	-	-
	Poet Biorefining - Alexandria LLC	Alexandria	90	6	-	-
	Poet Biorefining - North Manchester LLC	North Manchester	90	6	-	-
	Poet Biorefining - Portland LLC	Portland	90	6	-	-
	Poet Biorefining - Shelbyville LLC	Shelbyville	94	6	-	-
	South Bend Ethanol LLC	South Bend	100	7	-	-
	The Andersons Marathon Holdings LLC	Logansport	130	8	-	-
	Valero Renewable Fuels LLC	Bluffton	118	8	-	-
	Valero Renewable Fuels LLC	Linden	135	9	-	-
	Valero Renewable Fuels LLC	Mt Vernon	100	7	-	-
IOWA	Absolute Energy LLC	St Ansgar	125	8	**4,694**	**15,460,024**
	ADM Dry Mill	Cedar Rapids	300	20	-	-
	ADM Wet Mill	Cedar Rapids	240	16	-	-
	ADM	Clinton	237	15	-	-
	Big River Resources LLC	West Burlington	92	6	-	-
	Big River United Energy LLC	Dyersville	100	7	-	-
	Cargill Inc	Eddyville	71	5	-	-
	Cargill Inc	Ft Dodge	130	8	-	-
	Corn Lp	Goldfield	75	5	-	-
	Elite Octane LLC	Atlantic	150	10	-	-
	Golden Grain Energy LLC	Mason City	120	8	-	-
	Grain Processing Corp	Muscatine	83	5	-	-
	Green Plains Inc	Shenandoah	80	5	-	-
	Green Plains Superior LLC	Superior	50	3	-	-
	Homeland Energy Solutions LLC	Lawler	196	13	-	-
	Lincolnway Energy LLC	Nevada	90	6	-	-
	Little Sioux Corn Processors LLP	Marcus	165	11	-	-
	Louis Dreyfus Co	Grand Junction	122	8	-	-
	Pine Lake Corn Processors	Steamboat Rock	73	5	-	-
	Plymouth Energy LLC	Merrill	55	4	-	-
	Poet Biorefining - Arthur LLC	Arthur	132	9	-	-
	Poet Biorefining - Ashton LLC	Ashton	68	4	-	-

STATE	RESPONDENT	CITY	MMGAL/ YR	MB/D	STATE SUM (MMGAL/YR)	STATE SUM (TONS PER YEAR)
	Poet Biorefining - Coon Rapids LLC	Coon Rapids	65	4		-
	Poet Biorefining - Corning LLC	Corning	90	6		-
	Poet Biorefining - Emmetsburg LLC	Emmetsburg	68	4		-
	Poet Biorefining - Fairbank LLC	Fairbank	132	9		-
	Poet Biorefining - Gowrie LLC	Gowrie	90	6		-
	Poet Biorefining - Hanlontown LLC	Hanlontown	80	5		-
	Poet Biorefining - Iowa Falls LLC	Iowa Falls	112	7		-
	Poet Biorefining - Jewell LLC	Jewell	90	6		-
	Poet Biorefining - Menlo LLC	Menlo	132	9		-
	Poet Biorefining - Shell Rock LLC	Shell Rock	128	8		-
	Quad Cnty Corn Processors Coop	Galva	38	2		-
	Siouxland Energy & Livestock Co-Op	Sioux Center	65	4		-
	Southwest Iowa Renewable	Council Bluffs	130	8		-
	The Andersons Marathon Holdings LLC	Denison	55	4		-
	Valero Renewable Fuels LLC	Albert City	135	9		-
	Valero Renewable Fuels LLC	Charles City	140	9		-
	Valero Renewable Fuels LLC	Fort Dodge	140	9		-
	Valero Renewable Fuels LLC	Hartley	140	9		-
	Valero Renewables Fuels LLC	Lakota	110	7		-
KANSAS	Arkalon Ethanol LLC	Liberal	110	7	**601**	**1,979,436**
	Bonanza Bioenergy LLC	Garden City	55	4		-
	East Kansas Agri-Energy LLC	Garnett	48	3		-
	Element LLC	Colwich	70	5		-
	Kansas Ethanol LLC	Lyons	80	5		-
	Mgp Ingredients Inc	Atchison	6	(s)		-
	Nesika Energy LLC	Scandia	10	1		-
	Prairie Horizon Agri Enrgy LLC	Phillipsburg	40	3		-
	Pratt Energy LLC	Pratt	55	4		-
	Purefield Ingredients LLC	Russell	55	4		-
	Reeve Agri Energy Inc	Garden City	20	1		-
	Western Plains Energy LLC	Oakley	52	3		-
KENTUCKY	Commonwealth Agri-Energy LLC	Hopkinsville	48	3	**53**	**174,559**
	Parallel Products Inc	Louisville	5	(s)		-
MICHIGAN	Carbon Green Bioenergy LLC	Lake Odessa	57	4	**387**	**1,274,612**
	Marysville Ethanol LLC	Marysville	60	4		-
	Poet Biorefining - Caro LLC	Caro	80	5		-
	The Andersons Marathon Holdings LLC	Albion	135	9		-
	Valero Renewable Fuels LLC	Riga	55	4		-
MINNESOTA	ADM	Marshall	48	3	**1,424**	**4,690,046**
	Agri-Energy LLC	Luverne	24	2		-
	Al-Corn Clean Fuel	Claremont	130	8		-
	Bushmills Ethanol Inc	Atwater	90	6		-
	Chippewa Valley Ethanol Co LLP	Benson	50	3		-
	Denco II LLC	Morris	30	2		-
	Granite Falls Energy LLC	Granite Falls	63	4		-
	Greenfield Global Corn Plus LLC	Winnebago	43	3		-
	Green Plains Fairmont LLC	Fairmont	110	7		-
	Green Plains Otter Tail LLC	Fergus Falls	60	4		-
	Guardian Energy LLC	Janesville	150	10		-
	Heartland Corn Products	Winthrop	140	9		-
	Heron Lake Bioenergy LLC	Heron Lake	68	4		-
	Highwater Ethanol LLC	Lamberton	72	5		-
	Poet Biorefining - Bingham Lake LLC	Bingham Lake	35	2		-
	Poet Biorefining - Glenville LLC	Glenville	48	3		-
	Poet Biorefining - Lake Crystal LLC	Lake Crystal	68	4		-
	Poet Biorefining - Preston LLC	Preston	55	4		-
	Valero Renewable Fuels LLC	Welcome	140	9		-
MISSOURI	Golden Triangle Energy LLC	Craig	21	1	**331**	**1,090,172**
	Icm Biofuels LLC	Saint Joseph	50	3		-
	Mid-Missouri Energy LLC	Malta Bend	60	4		-
	Poet Biorefining - Laddonia LLC	Laddonia	80	5		-
	Poet Biorefining - Macon LLC	Macon	55	4		-
	Show Me Ethanol	Carrollton	65	4		-

STATE	RESPONDENT	CITY	MMGAL/ YR	MB/D	STATE SUM (MMGAL/YR)	STATE SUM (TONS PER YEAR)
NEBRASKA	ADM Dry Mill	Columbus	313	20	**2,244**	**7,390,774**
	ADM Wet Mill	Columbus	100	7	-	-
	Alten LLC	Mead	25	2	-	-
	Aurora West LLC	Aurora	110	7	-	-
	Bridgeport Ethanol LLC	Bridgeport	54	4	-	-
	Cargill Inc	Blair	210	14	-	-
	Chief Ethanol Fuels Inc	Hastings	70	5	-	-
	Chief Ethanol Fuels Inc	Lexington	52	3	-	-
	E Energy Adams LLC	Adams	101	7	-	-
	Elkhorn Valley Ethanol	Norfolk	52	3	-	-
	Green Plains Atkinson	Atkinson	47	3	-	-
	Green Plains Central City LLC	Central City	100	7	-	-
	GreenAmerica Biofuels Ord LLC	Ord	57	4	-	-
	Green Plains Wood River LLC	Wood River	110	7	-	-
	Husker Ag LLC	Plainview	90	6	-	-
	Kaapa Ethanol LLC	Minden	87	6	-	-
	Kaapa Ethanol Ravenna LLC	Ravenna	125	8	-	-
	Mid America Agri Products LLC	Madrid	50	3	-	-
	Midwest Renewable Energy LLC	Sutherland	28	2	-	-
	Nebraska Corn Processing LLC	Cambridge	50	3	-	-
	Poet Biorefining - Fairmont LLC	Fairmont	128	8	-	-
	Siouxland Ethanol LLC	Jackson	95	6	-	-
	Trenton Agri Products LLC	Trenton	55	4	-	-
	Valero Renewable Fuels	Albion	135	9	-	-
NORTH DAKOTA	Blue Flint Ethanol LLC	Underwood	73	5	**547**	**1,801,584**
	Dakota Spirit Agenergy	Spiritwood	77	5	-	-
	Hankinson Renewable Energy LLC	Hankinson	150	10	-	-
	Red River Biorefinery LLC	Grand Forks	17	1	-	-
	Red Trail Energy LLC	Red Trail	65	4	-	-
	Tharaldson Ethanol	Casselton	165	11	-	-
OHIO	CE Acquisitions Co LLC	Coshocton	50	3	**722**	**2,377,959**
	Guardian Lima LLC	Lima	73	5	-	-
	Poet Biorefining - Fostoria LLC	Fostoria	90	6	-	-
	Poet Biorefining - Leipsic LLC	Leipsic	90	6	-	-
	Poet Biorefining - Marion LLC	Marion	154	10	-	-
	The Andersons Marathon Holdings LLC	Greenville	130	8	-	-
	Valero Renewable Fuels LLC	Bloomingburg	135	9	-	-
SOUTH DAKOTA	Dakota Ethanol LLC	Wentworth	92	6	**1,444**	**4,755,917**
	Glacial Lakes Energy LLC	Watertown	148	10	-	-
	Glacial Lakes Energy LLC	Mina	162	11	-	-
	Hub City Energy LLC	Aberdeen	61	4	-	-
	Huron Energy LLC	Huron	38	2	-	-
	Nugen Energy LLC	Marion	150	10	-	-
	Poet Biorefining - Big Stone LLC	Big Stone City	105	7	-	-
	Poet Biorefining - Chancellor LLC	Chancellor	125	8	-	-
	Poet Biorefining - Groton LLC	Groton	68	4	-	-
	Poet Biorefining - Hudson LLC	Hudson	80	5	-	-
	Poet Biorefining - Mitchell LLC	Mitchell	86	6	-	-
	Poet Research Center	Scotland	12	1	-	-
	Red River Energy LLC	Rosholt	32	2	-	-
	Redfield Energy LLC	Redfield	65	4	-	-
	Ringneck Energy & Feed LLC	Onida	80	5	-	-
	Valero Renewable Fuels	Aurora	140	9	-	-
TENNESSEE	Dynamic Recycling LLC	Bristol	1	(s)	**236**	**777,283**
	Green Plains Obion LLC	Obion	125	8	-	-
	Tate & Lyle	Loudon	110	7	-	-
WISCONSIN	Ace Ethanol LLC	Stanley	52	3	**587**	**193,304**
	Badger State Ethanol LLC	Monroe	85	6	-	-
	Big River Resources Boyceville LLC	Boyceville	55	4	-	-
	Didion Ethanol LLC	Johnson Creek	50	3	-	-
	Fox River Valley Ethanol LLC	Oshkosh	64	4	-	-
	Marquis Energy-Wisconsin LLC	Necedah	50	3	-	-
	United Ethanol LLC	Milton	61	4	-	-
	United Wisconsin Grain Producers LLC	Friesland	60	4	-	-
	Valero Renewable Fuels LLC	Jefferson	110	7	-	-

STATE	RESPONDENT	CITY	MMGAL/ YR	MB/D	STATE SUM (MMGAL/YR)	STATE SUM (TONS PER YEAR)
TEXAS	Hereford Ethanol Partners LP	Hereford	120	8	**380**	**1,251,557**
	Plainview Bioenergy LLC	Plainview	130	8	-	-
	White Energy Hereford LLC	Hereford	130	8	-	-
COLORADO	Front Range Energy LLC	Windsor	40	3	**140**	**461,100**
	Sterling Ethanol LLC	Sterling	50	3	-	-
	Yuma Ethanol LLC	Yuma	50	3	-	-
IDAHO	Alto Magic Valley LLC	Burley	60	4	**60**	**197,614**
CALIFORNIA	Aemetis Advanced Fuels Keyes Inc	Keyes	70	5	**188**	**619,191**
	Calgren Renewable Fuels LLC	Pixley	55	4	-	-
	Parallel Products	Rancho Cucamonga	3	(s)	-	-
	Pelican Renewables LLC	Stockton	60	4	-	-
OREGON	Alto Columbia LLC	Boardman	40	3	**40**	**131,743**
U.S. TOTAL			**17,380**	**1,134**	**17,380**	**57,242,271**

(S)=Less than 0.5 Mmgal/yr or mb/d

Note: Totals may not equal sum of components due to independent rounding