THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

January 14, 2009

The Honorable Henry A. Waxman
Chairman
Committee on Energy and Commerce
U.S. House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

Enclosed is the report entitled "America's Energy Pipeline Network: Assessing Current Strengths and Identifying Future Challenges." This report complies with Section 8 of the Pipeline Inspection, Protection, Enforcement, and Safety Act of 2006 (PIPES Act), Public Law 109-468.

Pursuant to Section 8 of the PIPES Act, the Secretaries of Transportation and Energy analyzed the domestic transport of petroleum products by pipeline. More specifically, we identified areas of the United States where unplanned loss of individual pipeline facilities may cause shortages of petroleum products or price disruptions. Furthermore, we determined that the current level of regulation is sufficient to minimize the potential for unplanned losses of pipeline capacity. In our report we describe the national petroleum pipeline network and its relationships with refineries and terminals. We also discuss petroleum products supply disruptions and shortfalls and include recent case studies which augment our analyses.

An identical letter has been sent to the Ranking Member of the House Committee Energy and Commerce and the Chairmen and Ranking Members of the Senate Committee on Energy and Natural Resources; the House Committee on Transportation and Infrastructure; and the Senate Committee on Commerce, Science, and Transportation.

If I can provide further information or assistance, please feel free to call me.

Sincerely yours,

Mary E. Peters

Mary E. Peters

Enclosure

THE SECRETARY OF TRANSPORTATION

WASHINGTON, D.C. 20590

January 14, 2009

The Honorable John L. Mica
Ranking Member
Committee on Transportation
and Infrastructure
U.S. House of Representatives
Washington, DC 20515

Dear Congressman Mica:

Enclosed is the report entitled "America's Energy Pipeline Network: Assessing Current Strengths and Identifying Future Challenges." This report complies with Section 8 of the Pipeline Inspection, Protection, Enforcement, and Safety Act of 2006 (PIPES Act), Public Law 109-468.

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THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

January 14, 2009

The Honorable Daniel K. Inouye
Chairman
Committee on Commerce,
Science, and Transportation
United States Senate
Washington, DC 20510

Dear Mr. Chairman:

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January 14, 2009

The Honorable Jeff Bingaman
Chairman
Committee on Energy
and Natural Resources
United States Senate
Washington, DC 20510

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THE SECRETARY OF TRANSPORTATION

WASHINGTON, D.C. 20590

January 14, 2009

The Honorable Kay Bailey Hutchison
Ranking Member
Committee on Commerce, Science,
and Transportation
United States Senate
Washington, DC 20510

Dear Senator Hutchison:

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THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

January 14, 2009

The Honorable Pete V. Domenici
Ranking Member
Committee on Energy
and Natural Resources
United States Senate
Washington, DC 20510

Dear Senator Domenici:

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THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

January 14, 2009

The Honorable Joe Barton
Ranking Member
Committee on Energy
and Commerce
U.S. House of Representatives
Washington, DC 20515

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Committee on Transportation
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U.S. House of Representatives
Washington, DC 20515

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Enclosure

U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration

America's Energy Pipeline Network:
Assessing current strengths and identifying future challenges

A Department of Transportation report prepared in accord with the 2006 Pipeline Inspection, Protection, Enforcement and Safety Act.

October 1, 2008

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Illustrations

NOTES ON THIS REPORT

KEY TERMS

This report uses the word "oil" to describe crude oil, and the term "refined petroleum product"—abbreviated as "RPP"— to include all refined distillates of oil, such as gasoline, diesel fuel, aviation fuel, fuel oil, kerosene, any product obtained from refining or processing of crude oil, liquefied petroleum gases, natural gas liquids, petrochemical feedstocks, condensate, waste or refuse mixtures containing any such oil products, and any other liquid hydrocarbon compounds.

NAVIGATING

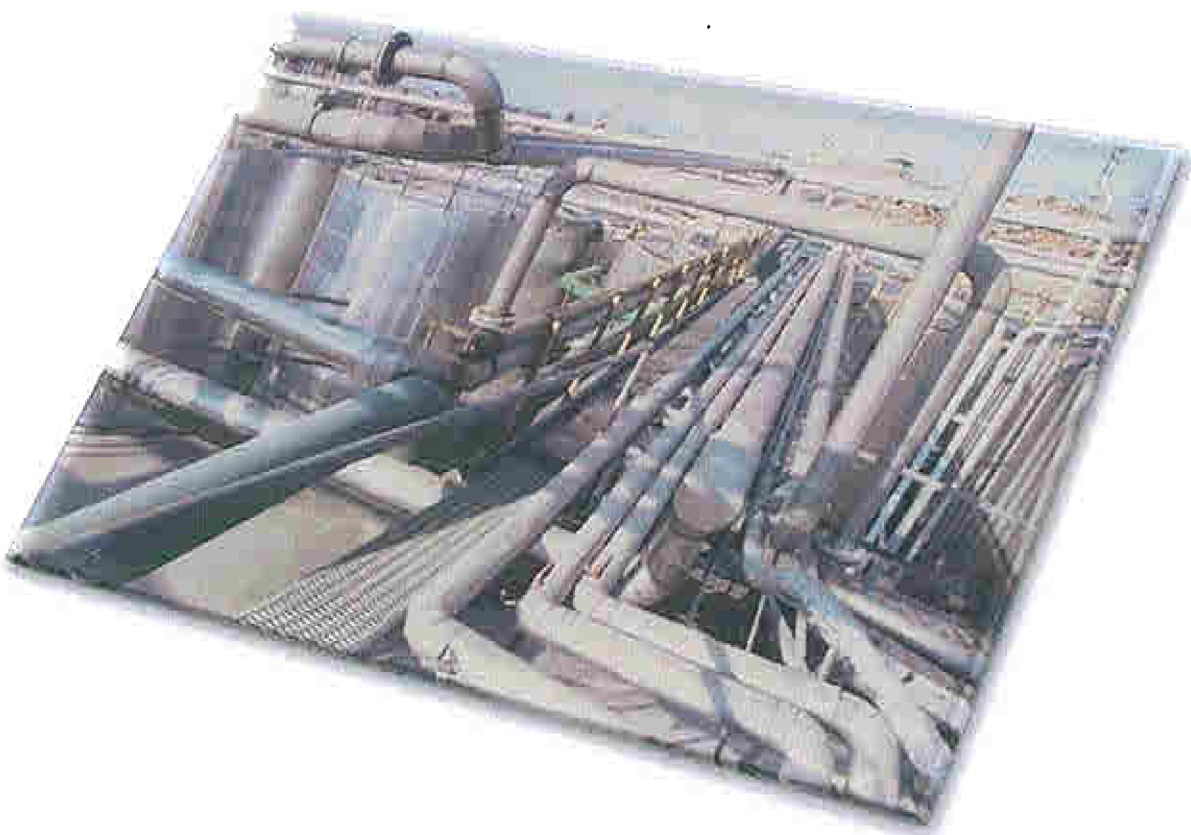
Readers viewing this report as a PDF file can navigate conveniently using internal hyperlinks. Hyperlinks appear in blue font.

TAKEAWAYS

In addition to the Conclusions provided at the end of this report, we list additional findings under *Section-at-a-Glance* and *Key Takeaway* headings. Readers wishing to navigate directly to those sections may do so via hyperlinks in the Table of Contents.

GLOSSARY

A glossary of terms used in this report can be found via this link: Glossary.



Abbreviations

AMS	Activity Manager System
bbl/d	Barrels per day
bbl/m	Barrels per month
bph	Barrels per hour
CAPP	Canadian Association of Petroleum Producers
CBG	Cleaner burning gasoline
CNR	Canadian National Railway Company
DHS	Department of Homeland Security
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
EOA	Eastern Operating Area
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
LPG	Liquefied Petroleum Gas
MMS	Minerals Management Service, Department of Interior's
NPGA	National Propane Gas Association
PADD	Petroleum Administration for Defense Districts
PHMSA	Pipeline Hazardous Materials and Safety Administration
PIPES	Pipeline Inspection, Protection, Enforcement and Safety Act
ppm	Parts per million
PREGS	Pipeline Repair and Environmental Guidance System
RPP	Refined Petroleum Product
RFG	*Reformulated gasoline*
RSG	Regional Security Group
SPR	Strategic Petroleum Reserve
TAPS	Trans-Alaska Pipeline System
ULSD	Ultra-low sulfur diesel
WOA	Western Operating Area
WTI	West Texas Intermediate

EXECUTIVE SUMMARY

This report was prepared in response to a directive from Congress, found in the 2006 Pipeline Inspection, Protection, Enforcement and Safety (PIPES) Act:[1]

> *The Secretaries of Transportation and Energy shall conduct periodic analyses of the domestic transport of petroleum products by pipeline. Such analyses should identify areas of the United States where unplanned loss of individual pipeline facilities may cause shortages of petroleum products or price disruptions and where shortages of pipeline capacity and reliability concerns may have or are anticipated to contribute to shortages of petroleum products or price disruptions. Upon identifying such areas, the Secretaries may determine if the current level of regulation is sufficient to minimize the potential for unplanned losses of pipeline capacity.*

[1] *Pipeline Inspection, Protection, Enforcement and Safety Act of 2006*, Public Law 109-468-Dec. 29, 2006, http://ops.dot.gov/library/docs/pipes_act_of_2006.pdf.

OVERVIEW

America's oil and refined petroleum product (RPP) transportation infrastructure is a reliable and resilient network of pipelines, pump stations and ancillary storage facilities. Although its component "parts" are owned and managed by dozens of different companies, the network can be thought of as a relatively complete whole, an integrated system that moves most of the liquid energy products we use to power our civilian, industrial and military sectors.

Generally speaking, America's energy transportation pipeline system is a success story. Integrating Department of Transportation (DOT) data with that of the Department of Energy (DOE), this report concludes that:

- The system has grown to meet the needs of a growing and mobile population.
- The system possesses sufficient resilience and redundancy to adjust and meet market demand when supply disruptions occur.
- America's metropolitan centers are well served, and most communities not directly served by pipelines are within a tanker truck day-trip from stocks.
- Pipeline operators have drawn important lessons from hurricanes, pipeline accidents and large-scale electrical power outages, implementing measures that will shorten the duration of supply disruptions in the future.
- New pipeline construction projects will have the effect of decreasing America's reliance on Gulf Coast facilities that are vulnerable to hurricane damage.
- Current regulatory requirements and pipeline inspection programs minimize potential for unplanned shortfalls, and in most cases where supply disruptions occur, pipelines are repaired and back in service within two days.

LOOKING AHEAD

DOT supports the intent of Congress to conduct a detailed analysis of our country's oil and RPP pipeline system. DOT is prepared to advance interagency agreements and work with agencies such as the Department of Energy and the Department of Homeland Security (DHS) to gather existing information and carry out additional research to fulfill the intent of the PIPES Act directive.

It is worth noting that DOE, DHS and private sector stakeholders have already created an informal working group, known as the Regional Security Group (RSG). The RSG has funded a series of studies aimed at identifying—for national security purposes—potential weak points in America's natural gas transmission system. There are currently no such studies underway that look at petroleum pipelines, but the RSG process may provide a useful model for carrying out a comprehensive interagency study of the America's energy transportation network. Such a study would further the intent of Congress, as reflected in the PIPES Act.

SECTION-AT-A-GLANCE

- Transportation and oil consumption in the U.S. are inextricably linked.
- America's privately-owned oil and RPP pipeline transportation network is safe, efficient, and reliable.
- Almost 70% of the oil transported through America's pipelines is refined into gasoline, diesel, and jet fuel.
- Where demand exists, pipeline operators will generally pump and provide as much product as they can, until they encounter a logistical restraint.

RECENT HISTORY

Up until the 1950s, America's supply of oil was produced, gathered, and processed from onshore oilfields, predominantly in Texas, Oklahoma, California, Pennsylvania and Ohio. Over time, additional oilfields—both on- and offshore—in Louisiana, Alaska and the Rocky Mountains were discovered and exploited. As the footprint of America's petroleum resource base expanded, oil and pipeline companies invested more and more in pipelines to move their oil to refineries.

Demand for RPPs began growing dramatically in the 1940s, and nearly tripled between 1950 and 2000. Oil consumption increased from 6 million to 16 million barrels per day (bbl/d) between 1950 and 2002, and from the 1940s through the 1960s domestic production increased sufficiently to meet this increasing demand. During the 1970s, however, demand outstripped supply in the United States.

This imbalance had two significant effects in the oil industry: it increased America's reliance on oil imports, and it increased our reliance on Alaskan and Gulf Coast sources that required massive investment in pipeline infrastructure. As a result, new long-haul pipelines were constructed to move oil from the Gulf of Mexico, Alaska and Canada into America's major population centers. [2,3]

THE INDUSTRY THAT MOVES AMERICA

Taken as a whole, America's energy sector is a trillion-dollar industry, directly comprising almost 10 percent of our nation's overall economic activity. More importantly, it is an industry on which every other industrial sector depends, so its importance is magnified at all times and becomes critical when, and where, supplies are diminished or threatened.

America's largest consumers of energy are the electrical power production and transportation sectors. Electricity is generated from a wide range of energy sources including coal, nuclear, natural gas, hydro, wind and sun. But, petroleum products meet 98% of our nation's transportation energy requirements, and the majority of those products—oil and RPPs—are transported through pipelines.

[2] Richard A Rabinow, *The Liquid Pipeline Industry in the United States: Where It's Been, Where It's Going, A Report Prepared for the Association of Oil Pipe Lines*, (April 2004).

[3] Cheryl J. Trench and Thomas O. Meisner, "The Role of Energy Pipelines and Research in the United States: Sustaining the Viability and Productivity of a National Asset" (Pipeline Research Council International, Inc., May 2006).

About two-thirds of the oil produced or imported into the U.S. is used in transportation. And about two-thirds of *that* amount is refined into gasoline, with the remainder converted into diesel, aviation fuels, and residual oil fuels.

In addition to powering our transportation and electrical power sectors, oil and RPPs serve as the key raw materials—known as *feedstocks*—used to create petrochemicals, plastics, solvents, and hundreds of other products.

Pipelines: Slow, Steady and Safe

Oil is transported in ships, on barges, in railcars, on trucks and by pipeline. Pipelines are unique in that they are integrated "linear assets" that traverse hundreds or even thousands of miles. Ships, barges, railcars, and tanker trucks, by contrast, are discrete units that rely on navigable waterways, rail systems, or highways for conveyance.

In many respects, America's energy pipeline network fulfills the same role for energy products as our highway and rail systems do for moving people and goods. Like interstate highways and railroads, pipelines—our energy highways—crisscross the nation and serve broadly dispersed populations. Unlike the highway system, however, our pipeline system is privately owned, and did not evolve from a government program.

Pipelines are generally the lowest cost and most environmentally benign method of moving energy products. They carry 75% of domestic oil shipments and more than 60% of RPP shipments. Maritime transport accounts for most of the remainder.

Pipelines move product slowly, but safely. Most products move through pipelines at three to eight miles per hour; so a trip from the Gulf Coast to Chicago takes about twelve days.[4]

Replacing the transport capacity of an average-size pipeline transporting 150,000 bbl/d requires the use of 750 trucks per day, or a train with seventy-five 2,000 barrel tank cars.

Types of Pipelines

America's energy pipeline network is composed of different types of lines, serving three distinct functions:

- *Gathering lines* bring oil from production fields to a processing facility or trunk line.
- *Transmission and trunk lines* are larger in diameter and cover considerable distances, carrying oil from production centers and port facilities to refineries. The Trans-Alaska Pipeline System (TAPS) and the Louisiana Offshore Oil Port pipeline are two examples of oil trunk lines. Colonial Pipeline Company and Explorer Pipeline Company are two prominent operators of RPP transmission pipelines. There are additional oil trunk lines that transport oil from production centers and ports to refineries, and distillate trunk lines that transport RPPs from refineries to population centers.
- *Distribution and delivery lines* are smaller diameter pipelines that move products to truck loading racks, and closer to their final destination.

[4] American Petroleum Institute, "Operational Flexibility," http://www.api.org/aboutoilgas/sectors/pipeline/flexibility.cfm

DOT-Regulated Pipelines

DOT, through its Pipelines and Hazardous Materials Safety Administration (PHMSA), regulates four types of pipelines: oil pipelines, RPP pipelines, liquefied petroleum gas (LPG) pipelines, and chemical pipelines.

Figure 1 provides a large-scale overview of the U.S. energy pipeline network. This includes 162,000 miles of DOT-regulated oil, RPP and LPG pipelines, and includes some pipelines that originate in Canada.

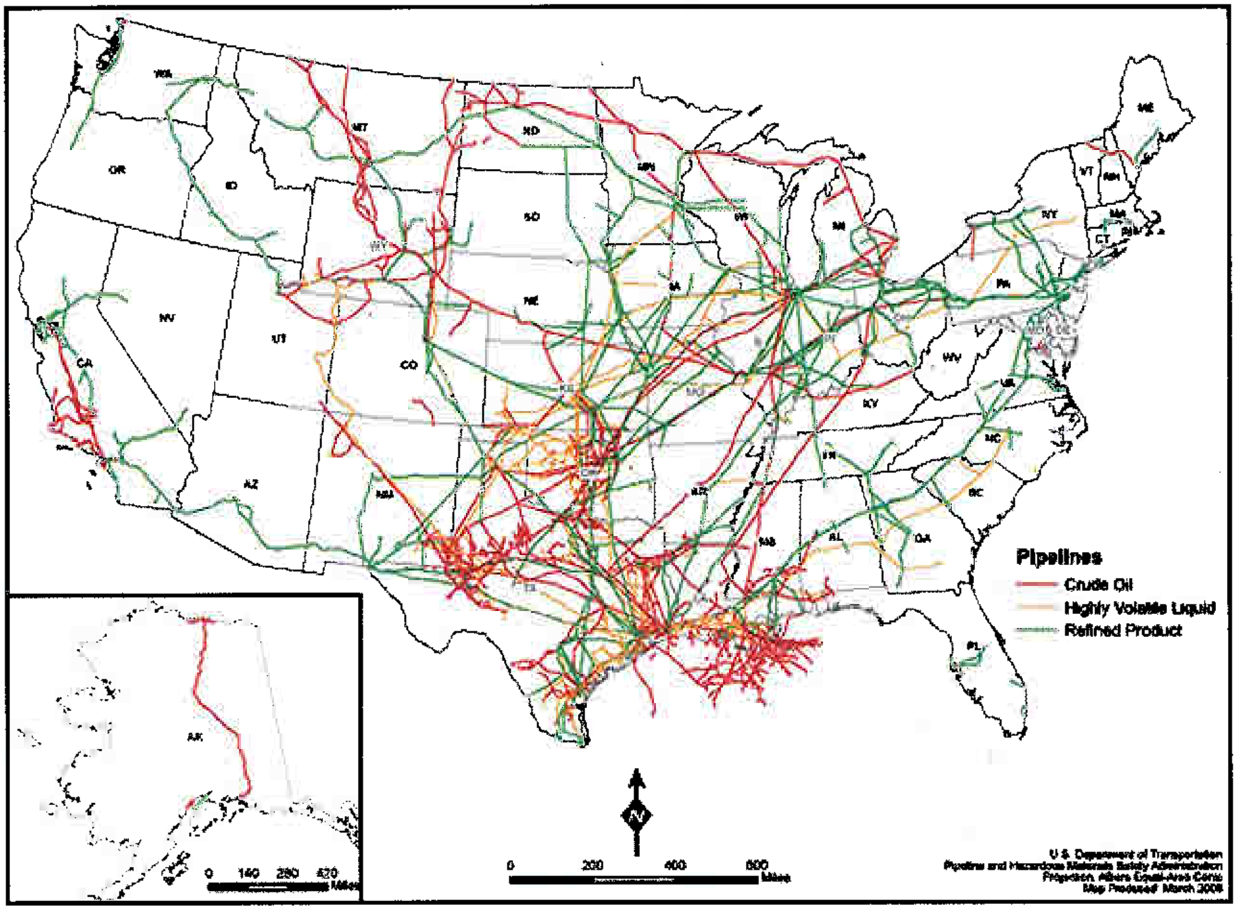


Figure 1: Overview of DOT-regulated oil, RPP and LPG pipelines.[5]

The preponderance of pipelines in the Southwest and Midwest are clearly evident in Figure 1. Also note:

- Most oil pipelines are destined for refineries in the Southwest, Midwest and California.
- RPP pipelines originate at refineries or at ports, and carry their products into population centers.

Oil pipelines connect oilfields and oil import terminals with oil refineries. Most originate in production areas in Texas, Louisiana, Oklahoma, the Rockies, and Canada, and transport oil to refineries in the Midwest and along the Gulf Coast. The Trans-Alaska Pipeline is an exception. It transports oil from

[5] U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, *Projection: Albers Equal-Area Con, Map*, (March 2008).

Alaska's North Slope to the marine terminals at Valdez. From Valdez, that oil is transported by tanker ship to West Coast refineries.

RPP pipelines move products from import terminals and refineries to wholesale terminals, storage depots, and airports around the country. The nation's largest RPP pipeline is operated by Colonial Pipeline Company. It moves products from Texas to New York, with wholesale terminals along the route.

Specialized pipeline systems transport LPG, in addition to non-energy products such as ethane (for petrochemical feedstock use), carbon dioxide (used in enhanced oil recovery processes) and anhydrous ammonia, primarily used for fertilizers.

Pipelines operate more efficiently than other modes of transport because they move commodities in very large quantities, and there is relatively little human intervention required.

Pipelines As Common Carriers

The Federal Energy Regulatory Commission (FERC) regulates interstate oil and RPP pipelines as common carriers. This means that FERC requires petroleum pipeline operators to provide open access to all shippers at non-discriminatory, cost-based rates. Intrastate oil pipelines are often subject to common carrier regulation as well, but that regulation is carried out by individual states.

To access space on a pipeline, a shipper must ask for the right to use capacity by nominating commodities to be received, delivered or stored by the pipeline company. Different shippers' nominations of like products are often combined by the pipeline company into "batches" in order to increase overall efficiency and minimize downstream processing requirements for separate batches.

Refined Petroleum Product Types

Several different types of refined petroleum products are transported by pipeline. They include: gasoline, kerosene, four different grades of distillate fuel oil (including diesel fuel), and LPGs, such as propane.

Gasoline

Since the 1920s, gasoline has been the dominant product refined from oil, accounting for about 45% of all oil use in the United States. The quest to maximize gasoline production has been the primary motivating force in development of refinery technology and design in the United States.

Fuel Oil

The use of distillate fuel oil ranks second behind gasoline in the United States. Unlike gasoline, which is used almost exclusively in the transportation sector, distillate fuel oil is used in every sector: for business and residential heating; for industrial power; for electrical generation; and for powering diesel-fueled vehicles.

The Environmental Protection Agency (EPA) requires that diesel fuel used on the highway—in trucks, buses and passenger cars—must be "low sulfur", or no more than 0.05% sulfur, by weight. Diesel fuel used off the highway—in marine applications, trains, farm equipment, industrial machinery, electric generation, or space heating—is not subject to the same low-sulfur standards. Even so, it typically contains only a small amount, about 0.2% by weight.

The U.S. Department of the Treasury also regulates diesel fuel, by requiring that it be dyed to distinguish it from the on-highway (and taxable) variety. These requirements tend to limit distribution flexibility for distillate fuels by requiring segregated storage and transportation facilities, and by preventing one product from easing market shortages of another.

The use of distillate fuel oil for home heating was once much more prevalent than it is now. In many parts of the country, homeowners are now using natural gas for space and water heating. Natural gas is the preferred choice for new construction.

Jet fuel

Kerosene-based jet fuel is the third-ranking RPP in terms of demand and, like gasoline, is primarily used in the transportation sector. There is some limited use of jet fuel as a stationary turbine fuel, and occasionally it is used to blend into heating oil to stretch supplies during periods of peak demand. In recent years the military has largely converted its aviation fleets from naphtha-based products to kerosene-based products.

Residual fuel oil

Residual fuel oil—a heavy fuel used to run stationary boilers for power generation and to propel tankers and other large vessels—once accounted for a significant share of consumption in the U.S. It comprised some 30% of all oil burned in stationary uses, and 20% of total U.S. oil consumption.

Residual fuel oil's heyday occurred in the 1970s and represented a particular time in energy markets. Natural gas supply was constrained by federal regulations, and although U.S. refiners had little incentive to produce low-priced residual fuel oil, refineries in the Caribbean and in Venezuela filled in the gap, supplying the East Coast of the U.S. with residual fuel oil for electrical power generation, for heating apartment buildings, and for industrial power.

The market for residual fuel oil gradually eroded for a variety of reasons, including environmental restrictions and price competition from natural gas. Its use as an apartment building heating fuel is now largely confined to older buildings in New York City, and its use in electrical generation is limited to a few utilities in Florida and the Northeast.

Cumulatively, the decline in consumption of residual fuel oil has been decisive. By 2007, market share had declined from a historic high of 30% to just 5% for stationary uses, and from a historic high of 20% to just 3% of total U.S. oil consumption.

Economics of Oil and RPP Markets

Price signals

Markets send "price signals" that lead to actions or behaviors within given markets. For instance, when the oil market sends a price signal indicating strong demand in Chicago, market participants typically respond by moving oil from Gulf Coast refineries to the Chicago area.

Price signals efficiently communicate economic information. They educate market participants—importers, producers, shippers, marketers, traders, and consumers—about short-term market conditions and longer-term trends.

Key decisions for refiners

Because oil markets are characterized by constant change and activity, decision-making is constant within those markets, and has a big impact on profits.

Setting the Slate

One key variable weighed by oil and RPP refiners has to do with oil selection. This refers to the "slate" of oils that a refiner selects and schedules to move through a given pipeline over a given period of time, and it is highly deterministic in predicting profit.

Oils are assigned grades based on their quality, and since different grades sell for different prices, oil and grade selection at the "front end" largely determines the cost of refined distillates at the "back end" of the supply chain. That's why oil selection is so important to the refiner's bottom line. Setting the slate determines about 85% of a refiner's potential profit in any given time period.

Targeting the Product

Once refiners set the slate and determine how much gasoline and distillate to refine in a particular month, they must then decide which markets to sell their products into.

In some cases this decision has already been made, due to existing supply contracts with major customers or the need to supply company-branded entities in specific regions. For decision-making outside those established dynamics, however, refiners evaluate *price differential* in deciding where to ship products.

Price differential consists of the value of a product in a given region, minus the cost to produce the product and ship it there. Some markets, such as Chicago, have a historically positive price differential for refined products shipped from the Gulf Coast, and therefore, oil companies often sign long-term contracts with pipeline or barge operators to move products into the Chicago area.

Other markets, such as New York, seem to be shifting from a historically positive price differential to a flat or negative one. This shifting pattern is changing the way companies think about transporting oil and RPPs, and the ways they will supply key markets.

The Bottom Line

Oil companies have an economic incentive to refine and ship products into markets where demand is strong. To maximize profits, they will ship as much product as possible, until they encounter some kind of restraint. The logistical capacity of a pipeline system is a primary constraint; and total available demand is another, implicit constraint. An oil company cannot long supply more product than people are willing to buy, without having it affect prices.

Where pipeline capacity is adequate and alternative transport modes such as barges and tanker trucks exist, fuel prices tend to be closely linked to prices in major wholesale markets, such as the Texas Gulf Coast. Where pipeline capacity is insufficient and alternative transport modes are few, prices tend to rise until they reach levels sufficient to reduce demand and/or to justify more expensive modes of transport.

SECTION-AT-A-GLANCE

- America's energy pipeline system consists of two inextricably linked types of strategic assets, pipelines and storage facilities. An increase in one type of asset will always necessitate an increase in the other.
- RPP pipeline systems have evolved to supply major population centers throughout the United States. Communities not directly supplied by pipelines are generally within one tanker truck day-trip of pipelines or storage facilities.
- Pipeline companies continuously evaluate existing systems to determine where capacity may be added, or new pipelines constructed to penetrate new markets.
- Due to their strategic importance in responding to supply disruptions, pipeline and storage capacity levels should be evaluated for adequacy.
- Industry data concerning quantities of oil and RPPs transported are commonly reported in terms of ton-miles or barrel-miles. These metrics are problematic for a number of reasons, and a need exists to develop more robust metrics for such measurements.

REFINING CAPACITY

> A note about pipeline capacity
>
> Pipeline experts use the term "capacity" in a lot of different ways. For example, design capacity differs from hydraulic capacity, while peak capacity differs from average daily capacity. And it would not be unreasonable to say that a pipeline company meeting all its shippers' commitments is operating "at capacity." But no matter what kind of capacity is being discussed, it probably relates to another concept known as pipeline "utilization."
>
> Utilization rates below 100% do not necessarily imply that additional capacity is available, because most pipeline systems only approach their maximum operating pressures for short periods, and sometimes only seasonally. A pipeline company that primarily serves a seasonal market, for instance, may have a relatively low average utilization rate.
>
> Pipeline utilization rates also ebb and flow with changes in end-use demand. During periods of high demand, utilization on some parts of a pipeline system may exceed 100% of design capacity, but that is not a cause for alarm. Design capacity represents a minimum level of service that can be maintained over an extended period, not the maximum throughput capability of a system or segment on any given day.
>
> Exceeding 100% of capacity is accomplished through the use of secondary pump stations or by increasing the horsepower of existing pump stations—within safety limits—to raise throughput temporarily. Depending on a pipeline's configuration, some pipeline companies also increase average-day utilization rates by integrating intermediate supplies from storage terminals into their pipeline network.

U.S. refining capacity has been stable in recent years, at about 17.5 million bbl/d. While this is a reduction from overall refining capacity of decades past, refineries that were shut down as demand fell in the early 1980s were those that had little *upgrading capacity*.

Upgrading capacity refers to the ability of a particular refinery to produce more-refined, higher-value products. Since they were limited to performing simple distillation, less-advanced facilities were only economically viable while receiving subsidies under a federal price control system that ended in 1981.

Gradually, in the 1980s and 1990s, refiners closed their less-profitable facilities. At the same time, they improved efficiency of their remaining oil distillation units by removing bottlenecks that impeded product flow, by matching capacity among different units, and by automating processing and control systems.

During this period, environmental mandates began having an effect, by encouraging both development of more benign products and improvement of upgrading capacity at existing plants. As a result of these adaptations, upgrading capacity ceased to be a major constraining factor on the amount of oil processed in the United States. Oil inputs to refineries and overall capacity utilization—the share of capacity filled with oil—rose throughout much of the 1990s. Capacity utilization reached record levels in the latter half of the 1990s, even exceeding 100% for brief periods.[6]

As shown in Figure 2, the Gulf Coast region is America's clear leader in refining capacity and RPP production. The Gulf Coast ships refined product to all U.S. regions, with the bulk going to the East Coast, where it provides more than half of that region's requirements for products like gasoline, heating oil, diesel, and jet fuel. The Gulf Coast is a major supplier to the Midwest as well, where it satisfies more than 20% of RPP demand.

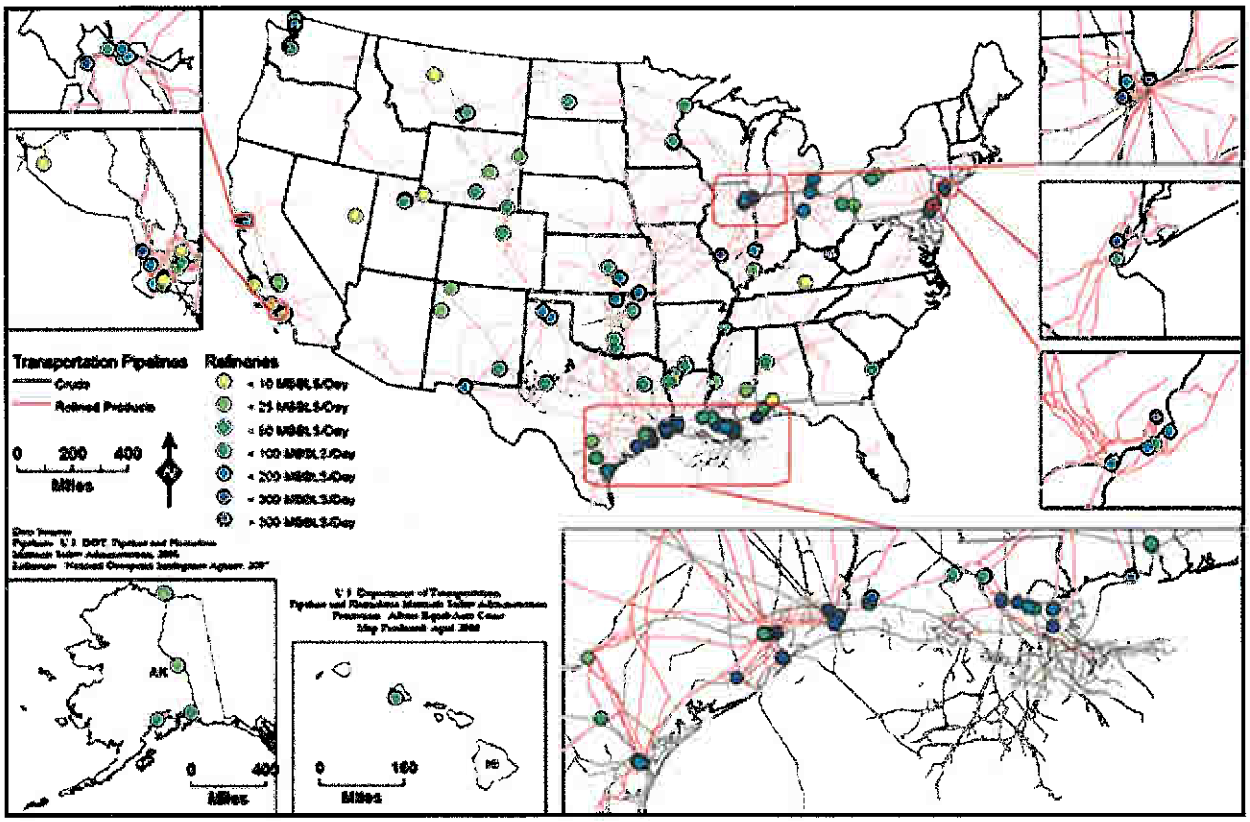


Figure 2: U.S refineries and refining capacities.[7]

Correlating Refining Capacity with Demand

Oil pipelines (shown as dark gray lines in Figure 2) typically terminate in states with large refining capacity. RPP pipelines (red) typically terminate in states with large demand. We also derive that states with very low demand for RPPs have the fewest pipelines. Supplies in those states are generally delivered using alternate modes of transport.

Exceptions to the Rule

Florida, however, is an anomaly. Florida has the fourth-largest population and the third-largest energy demand, yet it has no refineries and no interstate pipelines. Florida's entire demand is met through

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[6] Energy Information Administration, "Official Energy Statistics from the U.S. Government – Refining," http://www.eia.doe.gov/pub/oil_gas/petroleum/analysis_publications/oil_market_basics/refining_text.htm.

[7] Map drawn from data acquired from the Energy Information Administration, "Official Energy Statistics from the U.S. Government –Ranking of U.S. Refineries," http://www.eia.doe.gov/neic/rankings/refineries.htm.

marine imports. RPP movements are carried out in Florida by tanker truck and through eight *intrastate* pipelines with a combined 370 line-miles.

Of these, Central Florida Pipeline Company's pipeline is the longest. It is 203 miles long and serves markets from Tampa to Orlando. The next longest, at thirty-five miles, is operated by the Everglades Pipeline Company, which serves Miami International Airport from Port Everglades. The eleven mile Tampa Pipeline serves Tampa International Airport and the one mile CITGO pipeline serves Ft. Lauderdale Airport. Remaining Florida pipelines serve small local markets or power plants.

New York is another anomaly. Although it has the fourth largest demand, after Florida, Texas and California, it has no refineries. Most of New York's supply originates in the Gulf Coast and coastal refineries in New Jersey and Pennsylvania, which are in turn supplied by marine tankers. Also contributing to meet New York's demand are inland refineries in Pennsylvania that receive oil from pipelines that originate in Canada and the Midwest.

STORAGE FACILITIES

Oil and RPP storage terminals are another significant component of our domestic energy pipeline system. They are critical to pipeline operators for managing inventories and monitoring overall pipeline operations.

Reliable data on oil and RPP storage facilities is sparse. The Department of Defense's Mission Assurance Division (DOD) compiles this information, but also provides cautions that their data sources provide widely divergent findings. DOE also asserts that storage-related data from commercial sources, although useful, need to be corroborated. Towards this end, DOE and DOD are working to collect more data on the locations, size and stocks of storage terminals.

Caveats aside, our analysis suggests there are approximately 1,600 oil and RPP storage terminals in the United States, with a capacity exceeding 50,000 barrels. Approximately 18% of these terminals store oil, and the remainder store RPPs.

Figures 3 and 4 illustrate the general distribution of these terminals in the continental United States, and give some indication of the location of stocks that might be available in case of pipeline disruptions. Unsurprisingly, these stocks are found primarily along the coasts and in the Midwest. The rest of the country does not entirely lack critical storage capacity, however. For example, although Arizona has only four storage terminals, the largest ones are located in Tucson and Phoenix, where demand is highest.

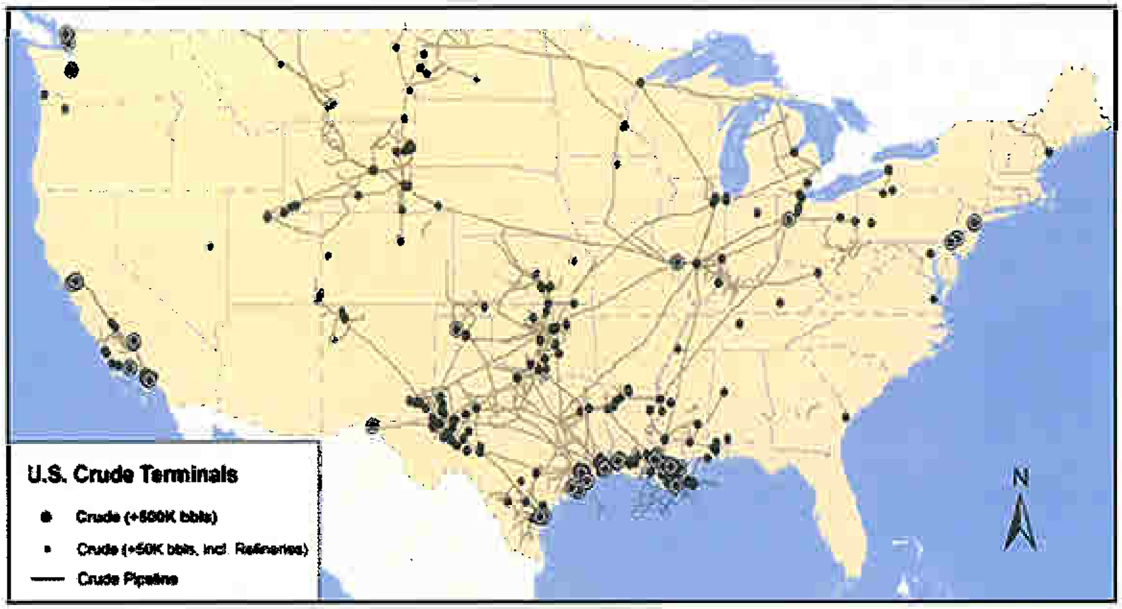

Figure 3: Oil storage terminals in the continental U.S.[8]

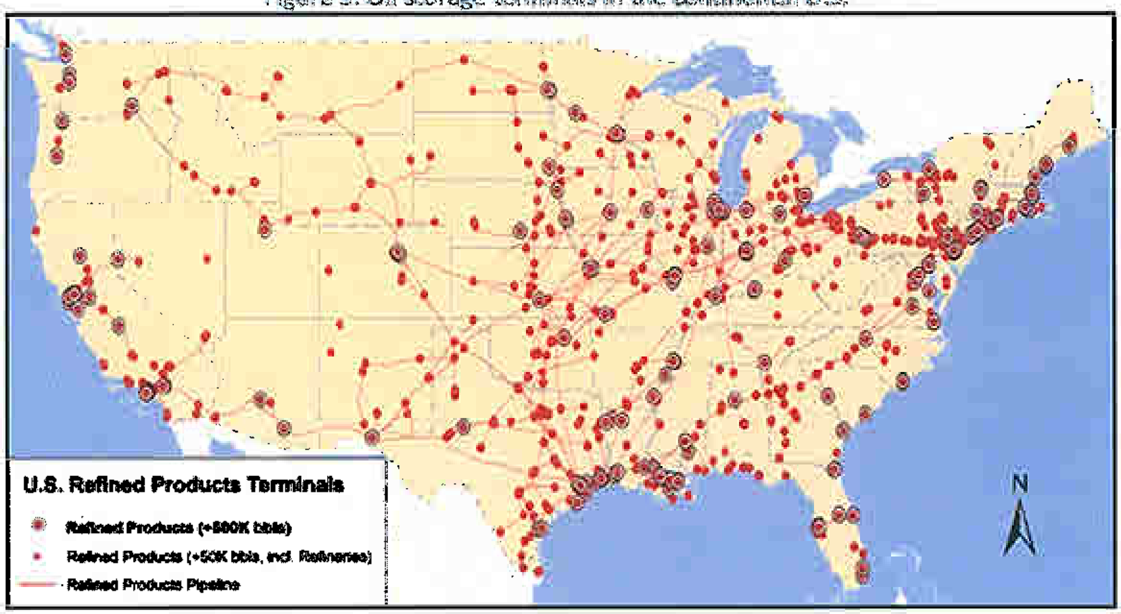

Figure 4: RPP storage terminals in the continental U.S.[9]

Oil and RPP Inventories

Inventory control is key to any business, and it is absolutely critical when it comes to our nation's oil and RPP supplies. Efficient inventory control smoothes operations and helps to mitigate supply disruptions.

A quick glance at inventory "levels":

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[8] Map Credit: Department of Defense, Mission Assurance Division.

[9] Ibid.

- *Primary inventories* comprise the oil and RPPs held at production sites, refineries, and storage terminals, as well as in pipelines, tankers, and barges.
- *Secondary inventories* are those held in retail outlets and storage facilities with less than 50,000 barrels total capacity. Secondary inventories are found "between" the primary distribution system and the end user.
- *Tertiary inventories* are products in the possession of end-users; for example, the gasoline in your automobile's tank.

The federal government maintains a supply of oil in the Strategic Petroleum Reserve, as well as a heating oil reserve in the Northeast, to be used in the event of a major supply shortage.

DISCRETIONARY STOCKS

According to the Energy Intelligence Group's 1997 report, *"How Much Oil Inventory is Enough?"* [10] there are 7-8 billion barrels of oil in global industry and government inventories at any given time. These inventories, sometimes known as "discretionary stocks," buttress the global system and help it operate efficiently.

Although discretionary stocks are small in terms of overall global volume, they serve an important role, indicating whether markets have too little, too much, or just the right amount of oil. When stocks are low in a particular region, prices will be relatively high, encouraging buildup of extra supply or reducing demand. Where stocks are high, prices are likely to trend lower. Discretionary stocks thus serve as an important leading indicator of future prices and are one of the most-watched metrics in the global energy industry.

The United States, with a large and widely dispersed oil market, has approximately one billion barrels of discretionary stock at any given time. The Gulf Coast holds the greatest part of this stock, while the East Coast, with high consumption and limited local supply, has large inventories of refined products.

OIL AND RPP PIPELINE NETWORKS

Figure 5 illustrates the volume of oil and RPPs transported domestically, by all modes. It illustrates that:

- Volume transported has consistently declined, from a peak of about 1200 billion ton-miles to about 900 billion ton-miles in 2004.
- Between 1984 and 1997, more oil than RPPs was transported by pipeline.
- Since 1998 the volume of RPPs transported has consistently outpaced the volume of oil transported, and in 2004 more RPPs were transported than in any previous year.
- From 1997-2004 the increase in RPPs transported has risen by slightly more than 10%, and oil transported has decreased by about 30%.

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[10] Heather Rowland, *"How Much Oil Inventory is Enough? Implications of stock changes for oil markets, governments and the oil industry"* (Energy Intelligence Group, 1997).

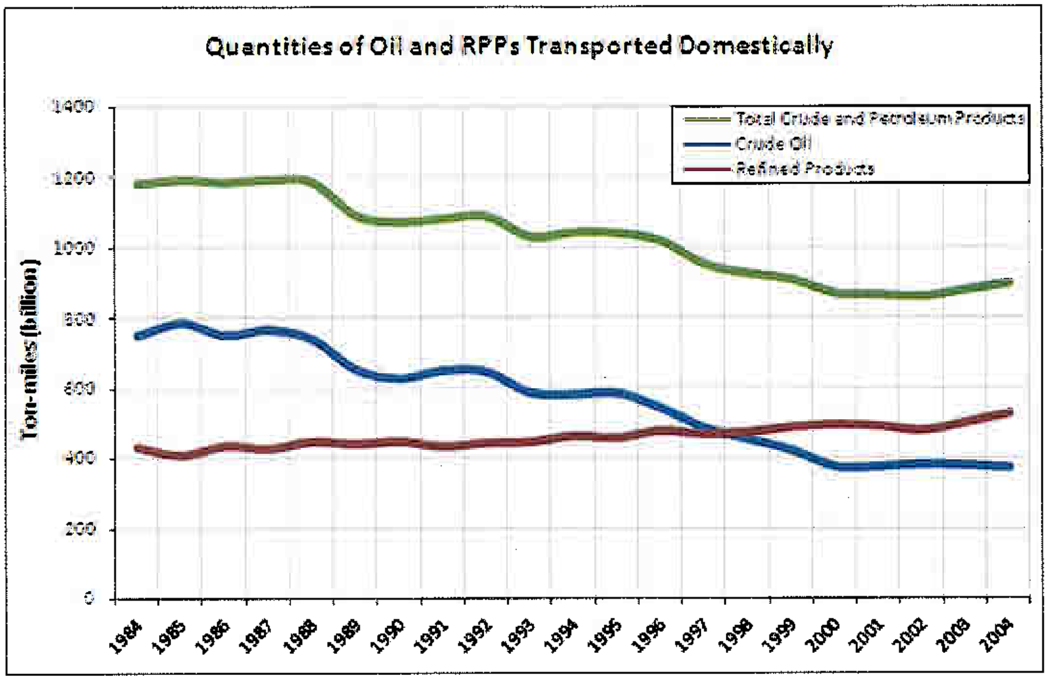

Figure 5: Quantities of oil and RPPs transported domestically.[11]

Similar to the aviation industry's use of "passenger-miles" as a unit of measure, ton-miles is a hybrid unit that quantifies the distance that freight is moved. Hybrid units are useful, but they also pose challenges, due to the fact that they do not tell us whether a large volume is moved a short distance, or a small volume is moved a large distance.

Preliminary data for 2005 compiled by the Association of Oil Pipelines (not shown) evidences a small increase in oil and RPPs transported via pipeline. In 2004 nearly 600 billion ton-miles were transported by pipeline. In 2005 this number increased to 611.2 billion ton-miles. Thus, from 2001 to 2005 there has been a gradual and consistent increase in oil and RPPs transported via pipeline, amounting to a net increase of about 7% over 5 years.

Our analyses make it clear that pipelines are the predominant transport mode for oil and RPPs. That has not always been the case, however, as illustrated in Figure 6.

In 1984, pipelines and marine transport were at parity. Transportation by pipelines increased until 1998, at which time it stabilized at or about 67% of the total transported by all modes. In 2004, total oil and RPPs transported was 902.5 billion ton-miles, and the share moved by pipelines amounted to some 600 billion ton-miles.

[11] Data compiled by the Association of Oil Pipelines from Annual Report (Form 6) of oil companies to the Federal Energy Regulatory Commission, U.S. Department of Commerce Economics and Statistics Administration, 2002 Economic Census. 2002 Commodity Flow Survey. Transportation. Hazardous Materials.

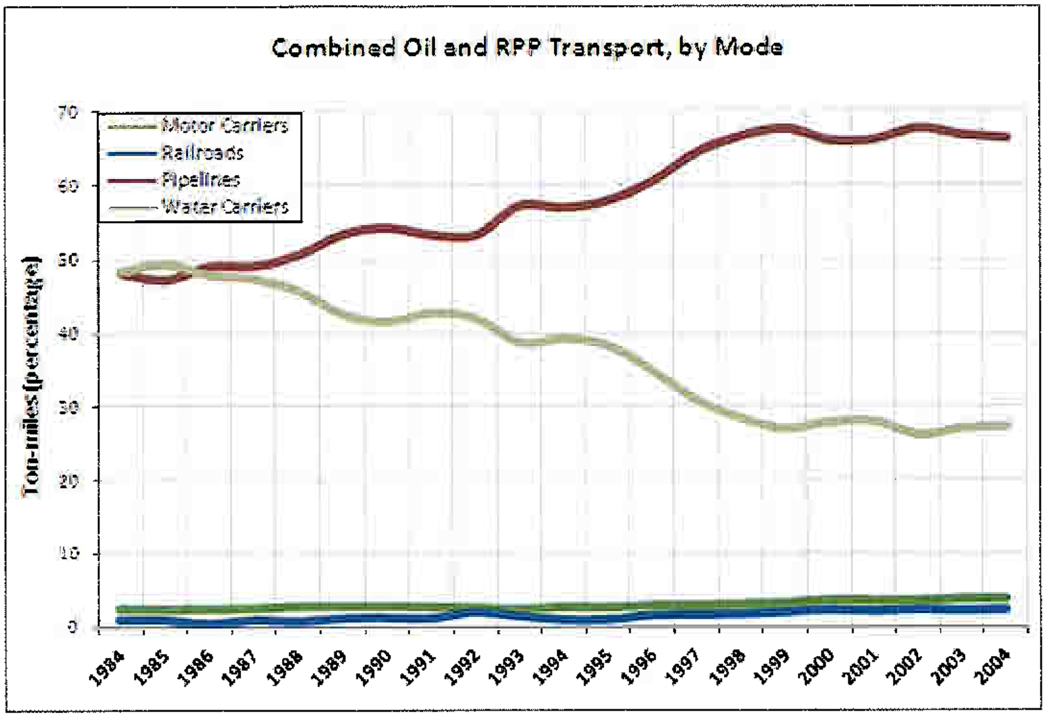

Figure 6: Combined oil and RPP transport, by mode.[12]

[12] Sources: Annual Report (Form 6) of oil pipeline companies to the Federal Energy Regulatory Commission; *Waterborne Commerce of the United States*, Department of the Army, Corps of Engineers, Part 5, Table 2-2, annual; Motor Carrier Annual Report (Form 15), Federal Motor Carrier Safety Administration and *Petroleum Supply Annual*, U.S. Department of Energy, Energy Information Administration, Volume I, Table 46; *Carload Way Bill Statistics, Report TD-1*, Department of Transportation, Federal Railroad Administration, annual, and *Freight Commodity Statistics*, Association of American Railroads, annual, Table A3.

It may be useful to break out separately the transport mode percentages for oil and RPPs.

Figure 7 illustrates that pipeline transport of oil grew from 44.5% in 1984 to 76% in 2004. That said, it is important to note that overall domestic oil transport has fallen by about 50% during that time period, from 784 billion ton-miles to 374 billion ton-miles.

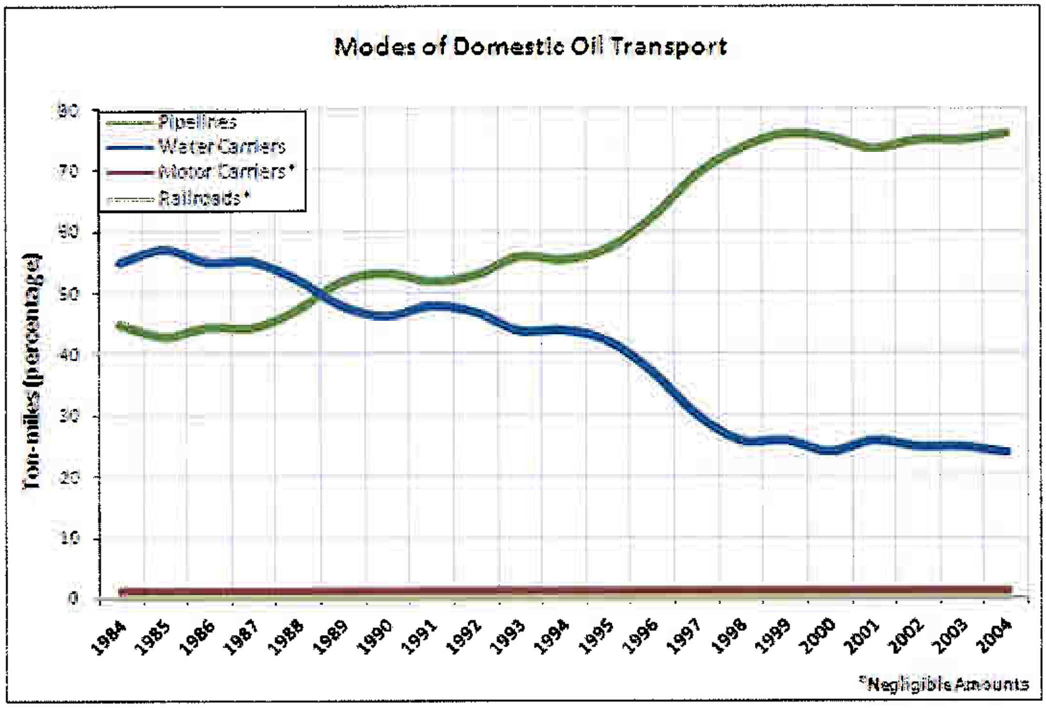

Figure 7: Modes of domestic oil transport.[13]

At this time it is useful to consider flows from the TAPS, which moves oil from Alaska's North Slope to marine transport terminals in Valdez, Alaska.

The Alaska North Slope reached peak production in 1988, when the TAPS transported slightly more than 2 million bbl/d. The TAPS is 800 miles long, so this equates to nearly 78 billion ton-miles/year. By 2004 Alaska North Slope production had declined to 935 million bbl/d, or about 36 billion ton-miles/year.

Even with the nearly 55% decline in North Slope production, total volumes transported by U.S. pipelines continued to increase across this timeframe. Much of the increase can be attributed to oil production from the Gulf of Mexico. Between 1990 and 2003, production in the Gulf of Mexico grew from 750,000 bbl/d to almost 1.6 million bbl/d, an increase of more than 100%.[14]

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[13] Sources: Annual Report (Form 6) of oil pipeline companies to the Federal Energy Regulatory Commission; *Waterborne Commerce of the United States*, Department of the Army, Corps of Engineers, Part 5, Table 2-2, annual; Motor Carrier Annual Report (Form 15), Federal Motor Carrier Safety Administration and *Petroleum Supply Annual*, U.S. Department of Energy, Energy Information Administration, Volume I, Table 46; *Carload Way Bill Statistics, Report TD-1*, Department of Transportation, Federal Railroad Administration, annual, and *Freight Commodity Statistics*, Association of American Railroads, annual, Table A3.

[14] J. Michael Melancon et al, *Gulf of Mexico Oil and Gas Production Forecast: 2004-2013*, U.S. Department of the Interior, Mineral Management Service, Gulf of Mexico OCS Region, OCS Report MMS 2004-065, (New Orleans: October 2004).

Projecting beyond the timeframe in Figure 7, the Minerals Management Service (MMS) forecasted that following a slight decrease in 2004, Gulf of Mexico oil production would continue to rise and approach 2 million bbl/d in 2007, after which it would likely decline to 1.75 million bbl/d in 2008.

Having evaluated modal transport for oil, and for combined oil and RPPs, it is useful to examine whether modal distribution has changed for RPPs only. Figure 8 illustrates the patterns from 1984-2004.

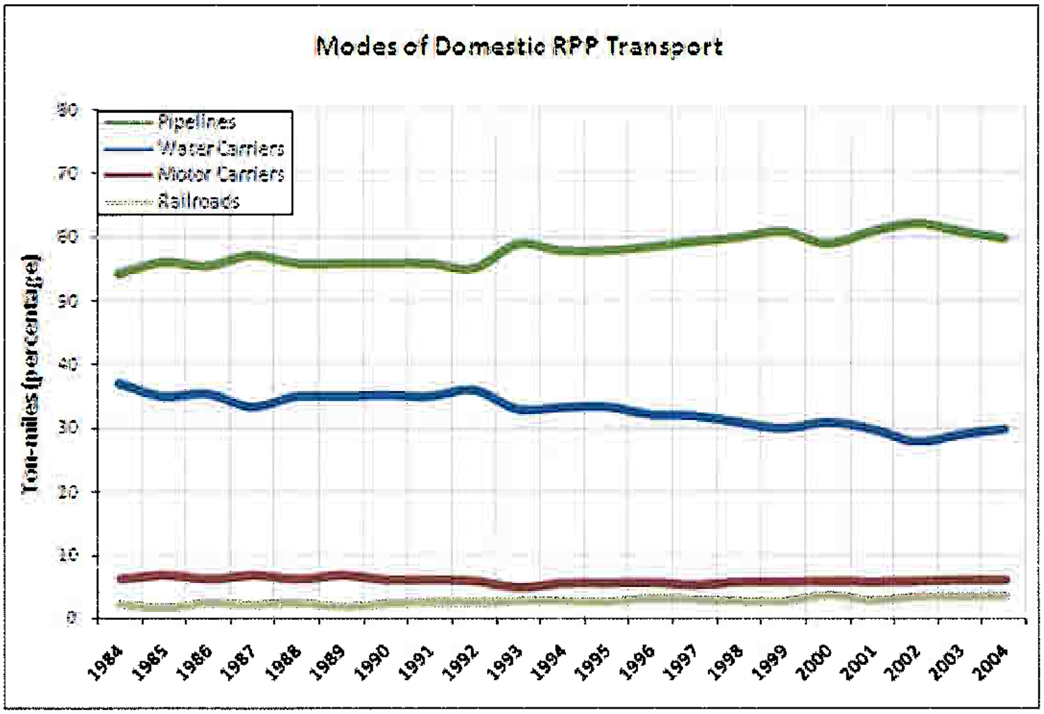

Figure 8: Modes of domestic RPP transport.[15]

Pipelines enjoy a stable, dominant position in this RPP transport ranking. In 1984, pipelines moved about 55% of RPPs; twenty years later they moved about 60%.

Without more information about changes in RPP pipeline mileages, it is difficult to draw defensible and precise conclusions about volumes transported. We know, however, that pipeline operators added some 10,000 miles of RPP pipelines between 1980 and 2006. Hence, we conclude that capacity was added, and this additional capacity helped keep the overall percentage of RPPs transported by pipeline relatively stable.

Supplying Our Population Centers

Different regions of the U.S. exhibit different oil consumption patterns. Population and regional economic activity are two important determinants of consumption rates, but other factors come into play as well, including availability of alternative fuels, challenges associated with petroleum transport, and geographical considerations.

[15] Sources: Annual Report (Form 6) of oil pipeline companies to the Federal Energy Regulatory Commission; *Waterborne Commerce of the United States*, Department of the Army, Corps of Engineers, Part 5, Table 2-2, annual; Motor Carrier Annual Report (Form 15), Federal Motor Carrier Safety Administration and *Petroleum Supply Annual*, U.S. Department of Energy, Energy Information Administration, Volume I, Table 46; *Carload Way Bill Statistics, Report TD-1*, Department of Transportation, Federal Railroad Administration, annual, and *Freight Commodity Statistics*, Association of American Railroads, annual, Table A3.

Of the five major regions of the country, the East Coast consumes the largest volume of oil and RPPs. On a per capita basis, however, the East Coast, Midwest and West Coast consume about the same amount, somewhat less than the Gulf Coast and the Rockies.

The Gulf Coast, the heart of the U.S. petroleum industry, presents an interesting case, because more than 25% of its consumption is not for direct use of oil for energy, but as a feedstock to make petrochemicals and petroleum-based products.

The Rocky Mountains are another interesting case. This sparsely populated region shows low consumption on an absolute basis, but high consumption per capita. High use of fuels to cover long distances is what makes the difference in the Rockies.

In 2000, 80% of Americans (226 million people) lived in cities, almost one-third of them in cities of at least 5 million people.

DOT has performed two distinct analyses to examine how pipelines have evolved to penetrate markets. Figure 9 shows RPP pipelines overlaid on a map of population density (number of persons per square mile), while Figure 10 shows RPP pipelines superimposed on a map showing county populations.

These maps appear similar, but we can extract different lessons from them. For example, in looking only at county populations (Figure 10), it appears that existing pipelines would adequately serve the markets of western and northwestern Montana. But when considering the population density map (Figure 9), it becomes evident that the population is spread widely over these rural counties, and other distribution methods are likely required to provide reliable and adequate supplies.

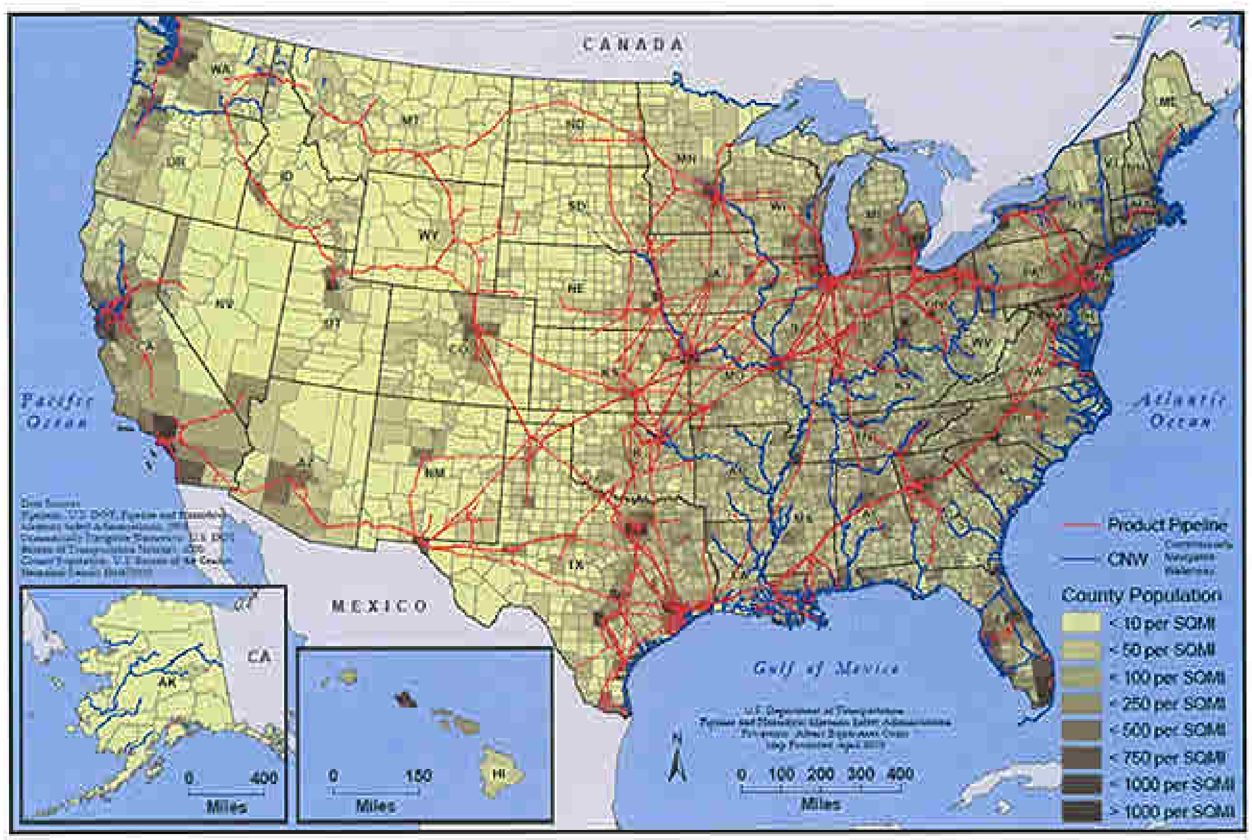

Figure 9: RPP pipelines relative to population density (with commercially navigable waterways).[16]

[16] U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, *Projection: Albers Equal-Area Con,* (April 2008).

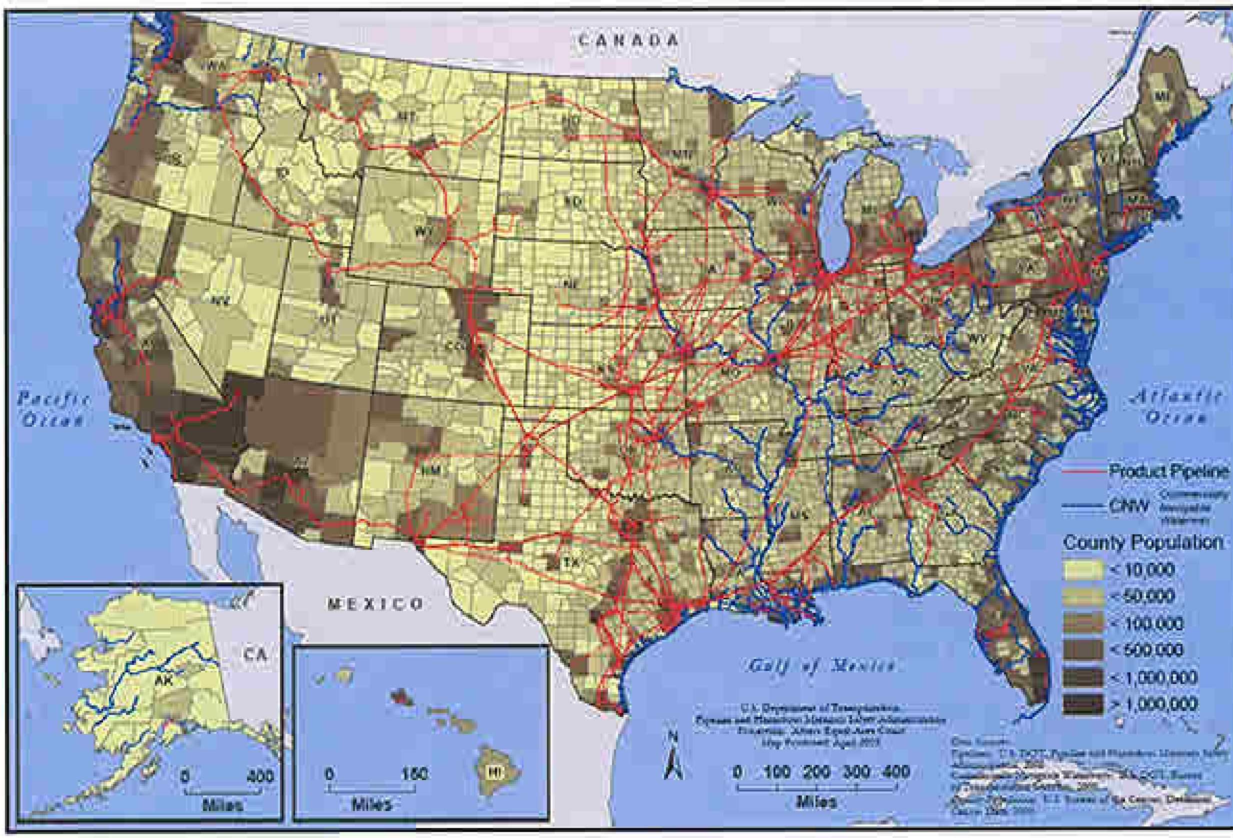

Figure 10: RPP pipelines relative to population levels (with commercially navigable waterways).[17]

These maps also show commercially navigable waterways in the United States. In densely populated portions of the Midwest and Northeast, commercially navigable waterways serve as an alternative delivery network.

We also derive from these maps that most moderately populated counties in the United States are within a tanker truck day-trip of a pipeline. (A day-trip, in this case, is defined as the time required to complete a 300-mile round trip, and an associated delivery.)

Notes on Population Data

In preparing this information, we evaluated preliminary population data from 2000 through 2007.

States experiencing double-digit percentage growth rates are:

- West: Arizona, Colorado, Idaho and Utah
- Gulf Coast: Texas
- South: Florida, Georgia
- Mid-Atlantic: North Carolina

[17] Ibid.

In comparing the 2000 census with the 1990 census, we concluded that most population growth occurring in the above states is in already well-established counties. It is likely that energy and pipeline companies are accounting for this growth in their capital investment plans.

A band of counties that lost population—in some cases declining more than 10%—stretches across the Great Plains states from the Mexican border to the Canadian border. A second band of slow growth counties includes much of the interior Northeast and Appalachia, extending from Maine through western Pennsylvania and West Virginia to eastern Kentucky.

SECTION-AT-A-GLANCE

- Pipeline companies, energy market participants, and government have demonstrated an ability to collaborate in response to sudden supply disruptions, helping to alleviate supply shortages and protect consumers.
- Pipeline disruptions are generally of short duration and flow levels are typically restored within two or three days, barring extraordinary circumstances.
- Pipeline companies continuously develop and update DOT-required emergency response plans, helping to ensure public safety and accelerate recovery times.
- Pipeline operators do not own the commodities they transport. If shippers or marketers elect to use alternate modes of transport or move their products to more-profitable markets pipelines will operate at less than maximum efficiency, or will, in other words, be underutilized.

Unexpected shortfalls in oil and RPP supplies can be caused by labor shortages, pipeline accidents, pipeline sabotage, refinery outages and weather-related conditions, any of which can and sometimes do disrupt supply-chains. When the price of oil is low, disruptions attract little notice, but when prices are high, relatively minor events often result in price spikes. In this section we examine several types of disruptions and shortfalls.

SHORTFALLS DUE TO PIPELINE ACCIDENTS

An unexpected shortfall can have outsized effects, because customers react to short-run fuel price rises. For example, an Arizona RPP pipeline accident in 2003 caused short-term gasoline prices to triple, even though the pipeline operator fulfilled its shipping commitments. (This is further described in Case Study 1.)

Due to the pipeline's configuration, the Arizona disruption not only caused prices to spike locally, but the burden from Arizona's increased demand contributed to higher prices elsewhere in the West. In California, prices rose 40 cents/gallon to peak at $2.10, and motorists in Washington, Nevada and Oregon experienced price increases of more than 30 cents/gallon.

This demonstrates that sudden and unexpected supply constraints can reduce supply *reliability* by causing adjustments, reallocations and price increases across the broader system. At the same time, and since the operator in the Phoenix case fulfilled its shipping commitments, it is likely that end-user hoarding behavior contributed to the apparent increase in consumption.

SHORTFALLS DUE TO MULTIPLE EVENTS

NEW ENGLAND PROPANE SHORTFALL, 2007

Despite strong inventories early in the 2007 heating season, extreme cold weather drove a surge of propane demand across the eastern U.S. in January. Ice storms across New England and the Mid-Atlantic region had disrupted both road and rail transport.

Against this backdrop:

- On February 10, 2007 some 2,800 of the Canadian National Railway Company's (CNR) union employees went on strike. CNR provides over 40% of upstate New York and New England's propane. Strike actions blocked tracks throughout the CNR system, and most immediately affected the citizens of Maine, where 50-70% of propane is supplied by rail.
- Marine transports of propane to the Providence, Rhode Island marine terminal had been slow, inventories were low, and no new deliveries were scheduled into the Newington, New Hampshire marine terminals.
- The Petroleum Administration for Defense Districts (PADD) regional inventory situation was not good. Although there were 34.7 million barrels of propane in national inventories on February 16th, the New England region (PADD District 1A) had only 85,000 barrels on hand.
- On February 20, 2007, Texas Eastern Products Pipeline Company (TEPPCO) discovered a leak on its propane pipeline in Seymour, Indiana, and ordered a shutdown.
- Available backup inventories at Todhunter, Ohio and Watkins Glen, New York were quickly exhausted, and fears arose that if the CNR strike continued, secondary and tertiary inventories would be exhausted by February 25th.

Market Participants' Response

In response to the shortfall, New England's regional and local propane marketers were forced to draw from recently-added extra storage capacity, while the propane industry as a whole implemented tactics to relieve the emergency situation:

- Northeast suppliers arranged for propane to be transported from storage facilities in Kansas, Michigan, and Iowa.
- Marketers communicated daily and shared supplies among themselves.
- Several southern New England marketers made propane available to their counterparts in Maine, while also helping local marketers whose supplies were dangerously low.

Government and Trade Associations' Response

Federal government agencies and industry associations coordinated their responses as well:

- At the request of the U.S. Department of State, the National Propane Gas Association (NPGA) sent a letter to the Canadian Ambassador to the U.S., informing him of the situation.
- The NPGA worked with its Canadian counterparts to monitor and communicate updates on the status of legislation introduced in the Canadian Parliament on February 21, 2007 that would end the CNR strike.
- The NPGA communicated with DOE regarding propane supplies, and with TEPPCO to track repairs to the Indiana pipeline.
- The NPGA also petitioned DOT for a regional exemption from commercial driver's rules, to ensure that Northeast states received adequate propane supplies during the strike. (As it happened, the supply situation stabilized before the waiver was put into effect.)

This example illustrates clearly that a broad-based, coordinated response among market participants and government players, combined with adequate pipeline infrastructure, can help alleviate supply shortages and protect consumers.

America's Heartland Diesel Shortfall, 2006

In July and August 2006, diesel supply shortfalls and corresponding price increases occurred in the Mississippi River Valley from Arkansas to Minnesota, and west to the Dakotas and Nebraska.

A number of factors led to this widespread shortfall, including regulatory actions, logistical challenges, and drought.

Regulatory Actions

Leading up to this period, the EPA had begun phasing in a new ultra-low sulfur diesel (ULSD) fuel standard for highway use. Pipeline companies had been converting over for some time, but refiners and storage terminal operators faced significant challenges. Refiners were required to produce the new ULSD by June 1st, while pipeline and storage terminal operators were required to deliver it by September 1st. Further along the supply chain, service stations were required to retail the new ULSD by October 15th.

Although the entire country was changing over to ULSD in this timeframe, the Heartland is particularly susceptible to shortfalls, because much of the region has few pipelines and little local refining capacity.

Logistical Challenges

In order to avoid contaminating the new ULSD, storage terminal operators needed to clear higher-sulfur diesel from their tanks. This required draining and refilling the tanks, which reduced the useful storage capacity of each terminal. With a smaller amount of fuel than usual in storage, supplies were vulnerable to sudden increases in demand.

The usual solution to this supply shortfall would be to bring in diesel by truck from more distant terminals, but in this case, the demand surge and supply shortfall was widespread.

In Nebraska, a shortage of diesel fuel had led to backups and delays at terminal sites, causing drivers to exceed their hours-worked limits, and preventing them from making rural deliveries.

On July 21, 2006, Nebraska's governor lifted the hours-worked restriction, freeing up drivers to fulfill their deliveries.

On top of all this, a refinery in Kansas closed in mid-July for scheduled maintenance that would last until August 14, 2006, aggravating the diesel shortage.

Drought

At the same time, the heartland was experiencing a severe and extensive drought, which increased fuel demand in farm country. The National Weather Service's Drought Monitor reported that virtually all of Nebraska was under either "severe" or "extreme" drought conditions. Central South Dakota had a large area of "exceptional" drought—the most serious level—while the rest of that state was in a severe drought. Conditions in other parts of the region ranged from abnormally dry to severe drought.

How does drought affect diesel fuel supply and prices? Large diesel engines power trucks, machinery, pumps, and motor-driven irrigators used by farmers. As the drought forced farmers to irrigate more, demand on existing diesel supplies was extreme.

Effect on Prices

According to the AAA Fuel Gauge Report, the average retail price of diesel on August 7th was $3.26 per gallon in South Dakota, $3.27 in North Dakota, $3.28 in Kansas, and $3.30 in Nebraska. These prices put this part of the country in a virtual tie with the far west for the highest diesel prices—an unwelcome development in the heartland, where prices usually rank in the middle.

Investigating the Shortfall

DOT studied the shortfall situation to determine if pipeline companies were responsible for diesel shortages and resulting price increases. We learned that Magellan MidStream, a pipeline operator, shut down their Donovan, Nebraska pump station due to lack of inventory. According to Magellan MidStream, the company did not have diesel to ship because refiners and marketers were sending supplies to more-profitable markets.

Kaneb, another pipeline operator that delivers diesel in Nebraska, notified DOT that the refinery they obtain diesel from was doing a turn-around to make the ULSD switch, and the only time they could reconfigure their systems and make these switches was during the month coinciding with the high from the agricultural sector.

We concluded that pipeline companies were not responsible for the shortfalls and price disruptions. Rather, a combination of drought, regulatory effects and logistical challenges had caused the diesel price increases.

Weather-related Disruptions

Extreme weather events

In 2005, Hurricane Katrina tested two important components of the U.S. energy transport system, the Colonial and Plantation pipelines.

Together, these two pipelines move some 2.9 million bbl/d of gasoline, diesel, and jet fuel to a swath of states running from Alabama through New Jersey. In the Southeast, they supply 60% of petroleum consumption, and are the sole source of aviation fuels for Dulles, Reagan-Washington, Newark, and Atlanta airports.

When Hurricane Katrina struck, it cut off electrical power to six pump stations in Southern Mississippi and shut down both pipelines. Access to the pump stations was blocked by fallen trees and communications went down. Even so, the Colonial and Plantation pipelines returned to full service within five days.

We provide a thorough analysis of hurricane-related oil and RPP flows in Case Study 3.

Hurricane Rita had fewer direct impacts on energy transport, but a large impact on energy production. Rita resulted in near-total loss of oil and natural gas production from the offshore Gulf of Mexico, along with the loss of some 15% of U.S. refining capacity along the Gulf for a period of several weeks. The lost oil production was replaced by imports in a relatively short period.

Key to the short duration of price spikes from Rita and Katrina was that the transportation system was able to sustain huge, unprecedented flows of products during the weeks following the storms. As affected refineries were returned to service, imports adjusted back to more-normal levels. However, the work of U.S. companies in overcoming formidable logistical challenges to organize cargoes, tankers, and terminals were central to limiting the energy price impacts of the hurricanes.

SHORT-TERM WEATHER EVENTS

On January 9 and 10, 2005, record rains caused washouts under four RPP pipelines serving customers—including airports and military bases—in California, Arizona, and Nevada. DOT requires pipeline operators to take remedial action immediately in such cases, and the operators shut down the pipelines.

In Clark County, Nevada (home to Las Vegas), gasoline suppliers began running out of product on January 11th. On January 12th, the EPA granted the county a waiver, allowing it to use alternative blends of gasoline. This waiver would be effective until midnight on January 18, 2005. EPA also worked on granting a similar waiver to affected counties in Arizona.

The pipeline system resumed service on January 12, 2005. At that time McCarran International Airport had about a 6-day supply of jet fuel remaining; Phoenix had 2 days worth of diesel and just 2.7-day's worth of regular gasoline remaining.

Responding to these short-term shutdowns, DOT worked with a number of different agencies and organizations to gather information about downstream inventories, including DOE, EPA, the Federal Railroad Administration, the California State Fire Marshal, the California Energy Commission and the Union Pacific Railroad.

Within four days of the shutdowns, the pipelines had safely resumed service.

DISRUPTIONS EXACERBATED BY DELAYS IN PERMITTING

When pipeline inspections or routine maintenance reveal critical defects, pipeline operators are required to complete repairs within a set time period. Repairs are often straightforward, and require little in the way of special permitting. There are exceptions, however, especially for longer pipeline sections, or for repairs at river crossings or around wetlands. In these cases, pipeline companies often need to acquire multiple permits from multiple agencies.

In one notable example, a pipeline company in California sought permits for a "reroute/replace" pipeline project between the cities of Concord and Sacramento. In all, the operator had to acquire forty-four permits, including three federal environmental permits, nine state environmental permits, seven local permits, four city and county permits, and twenty-one encroachment and excavation permits. Many such permitting processes take place sequentially, rather than simultaneously, and this can add considerably to the time required.

While the company was involved in these permitting processes, the pipeline that was to be rerouted and replaced ruptured, spilling more than 2,000 barrels of oil into the environmentally sensitive Suisun Marsh. And two months after the spill, seven permits were still outstanding for the project.

This is an example of how coordination and communication challenges sometimes delay pipeline repairs to the detriment of the public interest.

Expediting the Permit Review Process

In recent years, DOT, through PHMSA, has developed the Pipeline Repair and Environmental Guidance System (PREGS) with input and direction from a broad-based interagency committee. PREGS is a web-based resource for pipeline operators and regulatory agencies, designed to expedite the permit review process by enabling better communication, and standardizing an efficient methodology for permitting.

PREGS provides recommended Best Management Practices, knowledgeable points of contact, and an Activity Manager System (AMS). The AMS is an online tool designed to efficiently and effectively expedite environmental review and permitting processes. It enables federal, state and local agencies, along with pipeline operators, to participate in real-time pre-inspection planning and coordination, and to predict, as much as possible, what actions would need to be undertaken should a pipeline inspection and/or repair be necessary.

Disruptions Caused by Pipeline Repairs, Inspections, and Modifications

Pipeline repairs that require operating pressures be reduced, or that pipelines be taken out of service. This in turn reduces the amount of product transported.

Pipeline Repairs

In 2003, the Colonial Pipeline Company notified DOT that a compulsory repair and its associated pressure reduction might interrupt jet fuel deliveries to Philadelphia, La Guardia, and Newark airports during the Thanksgiving travel period. DOT collaborated with the pipeline company and implemented a set of evaluation, monitoring, response and repair procedures to enable safe, continuous operation of the pipeline during one of the most heavily traveled weekends.

Simultaneous Repairs by Multiple Pipeline Operators

Although there are, as yet, no documented cases of this type of shortfall occurring, unforeseen capacity shortages may be brought about when two or more pipeline companies serving the same market schedule simultaneous inspections or repairs.

Planned Capacity Reductions for Inspections or Modifications

Some inspection methods, such as hydrostatic testing, require that a pipeline be temporarily taken out of service. Other methods require temporary capacity reductions. Modifications of older pipelines to accommodate inline inspection devices may also create temporary service reductions. Such modifications are usually well-planned events, however. Markets tend to adjust for them, and prices are generally unaffected.

Shortfalls Caused by Introductions of New Fuel Blends

Summer Blends

In recent years, there has been a proliferation of "boutique fuels" in the United States. These are specialized blends that are required by municipalities to be used at different times of year, in order to help reduce air pollution.

In the United States, gasoline has been broken down into about seventeen different blends, sold in dozens of discrete markets. With three grades of gasoline available per blend, refiners are routinely producing over fifty separate sub-blends, and this creates challenges for pipeline operators. At any given time, Colonial Pipeline Company, whose pipeline system extends from Texas to New York, routinely has between twenty and twenty-five blends in their system.

When disruptions occur, it is often difficult to readily replace mandated supplies of boutique blends, since they may be located hundreds of miles away. During such periods it may be useful to temporarily lift boutique blend requirements. This would likely improve overall pipeline efficiencies in affected areas and encourage markets to more rationally exchange products. It may also help curb speculative consumption which increases local demand and, consequently, may help prevent spikes in gasoline prices.

Ultra-low sulfur diesel

As noted earlier, the EPA introduced in 2006 a rule requiring that sulfur content of ULSD not exceed fifteen parts per million (ppm). By contrast, regular diesel has a maximum sulfur content of 500 ppm.

Studies show that the use of ULSD will contribute to dramatic reductions in diesel emissions. Some petroleum industry participants grumbled that the fifteen ppm constraint would cause fuel shortages and price increases for diesel and other refined fuels. Shortages and price spikes did not materialize, however, because all sectors of the petroleum industry independently reconfigured and replaced their systems in order to meet the new requirements. And pipeline operators conducted tests on large batches of ULSD to evaluate contamination rates in the middle of the batch, and at batch interfaces.

Additionally, pipeline operators took the following steps:

- identified points of contamination within each facility
- dedicated systems to ULSD wherever practical
- calculated line displacements and updated displacement procedures
- modified batch sequencing
- enhanced training

Future blends

Neat ethanol, or ethanol blended with gasoline, will pose similar challenges for pipeline operators. DOT, along with other federal agencies, national laboratories, academic institutions and the pipeline sector itself, has funded research and development to determine how ethanol will affect pipe. Pipeline companies have conducted tests to evaluate pipeline performance using ethanol, and are proposing that DOT conduct similar tests.

Experience has shown that pipeline system inefficiencies do sometimes occur when new fuel standards are introduced, but the pipeline industry has generally succeeded in adapting to new standards over a relatively short period of time. Disruptions during transition periods have been regional in scope and limited in duration.

Shortfalls Caused by Long-term Shifts in Supply and Demand

Supply shortages falling under this category typically occur over a long period of time and across a significant geographical area, as new supply sources are exploited and populations ebb and flow. This type of shortage can be pronounced, since it takes large capital investments for pipelines operators to extend lines into new areas. But in some cases, pipeline companies can update or adapt existing infrastructure to address new opportunities.

Improving and Upgrading a Pipeline

The Longhorn Pipeline is a good example of how pipeline companies respond to changing conditions and adjust their operations to serve new or expanding markets.

In 1995, Exxon retired a 450-mile oil pipeline running from Crane, Texas to Baytown, Texas, on the Gulf Coast. The pipeline had been carrying crude oil southeast, from production areas around Crane to a refining facility in Baytown. Exxon retired the line because oil production in Crane had diminished, and the pipeline was no longer profitable.

Subsequently, oil production and refining activity along the Gulf Coast picked up, and in 1997 a group of affiliated companies saw an opportunity to leverage the mothballed pipeline.

Beacon Group Energy Investment Fund, Amoco Pipeline and Williams Pipeline joined with Exxon Pipeline to form Longhorn Partners Pipeline Company (Longhorn). Longhorn added 237 miles of new pipeline to the dormant line and linked it into a broader system of storage facilities, lateral lines and interstate pipelines. Where previously the pipeline had transported unrefined crude oil from onshore production facilities to the Gulf Coast, the Longhorn line now moves RPPs from the Gulf Coast to storage facilities and interstate pipeline connections that supply burgeoning population centers as far away as Arizona and New Mexico.

This shows that pipeline companies are continuously evaluating their operations, and are willing to invest in order to improve infrastructure when the economics make sense.

Reversing Pipeline Flow

Current drilling activity and industry forecasts for the Rocky Mountains region anticipate potential increases in production of Southwest Wyoming Sweet Crude oil and producers and shippers have sought transportation alternatives for these emerging oil supplies.

In June 2009, Rocky Mountain Pipeline System (RMPS) announced it had received a long-term customer commitment to transport Southwest Wyoming Sweet crude oil from RMPS facilities at Wamsutter, Wyoming to its facilities at Ft. Laramie. As a result, RMPS plans to reverse its Wamsutter pipeline, which currently transports Rocky Mountain Sweet crude oil from Ft. Laramie to Wamsutter. RMPS plans to complete the pipeline reversal in the first quarter of 2009.

The Wamsutter-Ft. Laramie reversal will provide shippers with a new solution for transporting their product east to Ft. Laramie or west into Utah, as dictated by demand.

Building New Pipelines

Another example of change in the pipeline industry is underway at our northern border. The Canadian tar sands industry is centered in Alberta, and more than one million barrels of synthetic oil are being produced from these resources every day.

Currently, tar sands represent about 40% of Canada's oil production. With additional investments pouring in, output is expanding rapidly. Approximately 20% of U.S. oil and RPPs come from Canada, and an increasing portion is coming from tar sands.

Competition and these increasing levels of supply are driving new pipeline investments to support the tar sands and increase Canadian exports into the U.S. In 2007, TransCanada Keystone Pipeline, LP (TransCanada) applied for a permit from DOT, requesting they be allowed to build a new pipeline and operate it at a higher-than-normal pressure. DOT granted the permit in April 2007, after evaluating TransCanada's proposal and applying more than fifty safety-related conditions to enhance the integrity of the pipeline.

That pipeline is now under construction and should commence service in late 2009.

Section Four: Case Studies of Major Supply Disruptions and Shortfalls

Section-at-a-Glance

- Pipeline operators across the U.S. have demonstrated that they can adjust to changes in consumption patterns.
- Fuel blending requirements vary widely among municipalities and states, and as a result, market participants are often unable to "fill in" supply shortfalls with available—though not identical—RPP stocks. An inability to substitute non-identical blends can exacerbate effects of supply disruptions.
- Pipeline systems are resilient and easily repaired, but they rely on commercial supplies of electrical power to operate. While power supplies are being restored, most pipeline systems are able to continue operating at diminished rates.
- RPP storage is critical to responding to and minimizing the effects of pipeline disruptions. Our analysis shows that incentives to maintain robust RPP inventories have diminished. A need and an opportunity exist for DOT and private industry to broadly assess our nation's RPP storage assets and balance them against storage requirements.

Case Study 1: July 2003, Kinder Morgan Energy Partners RPP Pipeline Accident

Case Study Key Takeaways

- Even with a severe pipeline disruption, Kinder Morgan met its Tucson and Phoenix markets' gasoline requirements.
- The more blends a pipeline company transports within its service territory, the more difficult logistics management becomes.
- Supply disruptions can result if a particular fuel blend from one area cannot be used to supply another area.
- A "run" on fuel, rather than a reduction in deliveries, accounted for much of the perceived supply shortfall arising out of this pipeline accident.

Overview

The Phoenix Fuels Complex in Arizona is supplied with RPPs from the west by a 20" pipeline that originates in Colton, California. To the east, the Phoenix Fuels Complex has an outgoing 6" line and an incoming 10"/12" combination line which delivers RPPs from Tucson. (This line originates in El Paso, but passes through Tucson on its way to Phoenix.)

On July 30, 2003, Kinder Morgan Energy Partners (KM), one of America's largest midstream pipeline operators, experienced a rupture on the combination line between Tucson and Phoenix, which shut off its Tucson-to-Phoenix supply. This incident attracted massive publicity across the West and spurred lawmakers to hold hearings at both state and national levels.

Following shutdown of the ruptured pipeline, KM performed repairs and then restarted the pipeline. Follow-on metallurgical analyses of the pipeline compelled a second shutdown on August 8, 2003, and the pipeline was eventually returned to service on August 21st.

Effect on Supplies

Figures 11 and 12 show RPP flows through KM's pipelines to Tucson. The 6" line from Phoenix was not affected, so RPPs continued to flow from Phoenix to Tucson. The company also instituted tanker truck deliveries of CBG from Tucson to Phoenix.

Due to challenges associated with the trucking operation, KM tied the combination line into the 6" line (upstream of the rupture site) and reversed the flow from the 6" to deliver product into Phoenix.

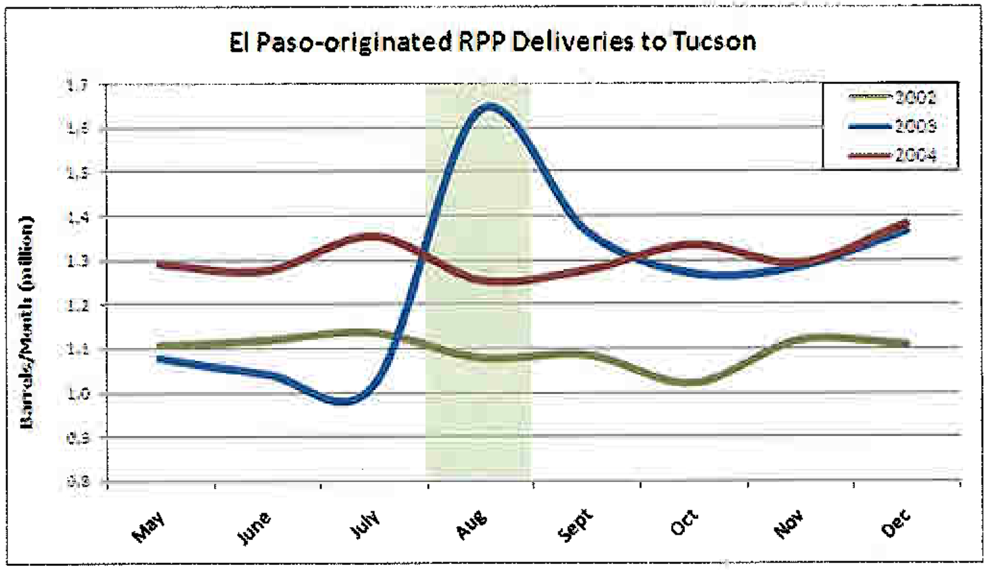

Figure 11: El Paso-originated RPP deliveries to Tucson.[18]

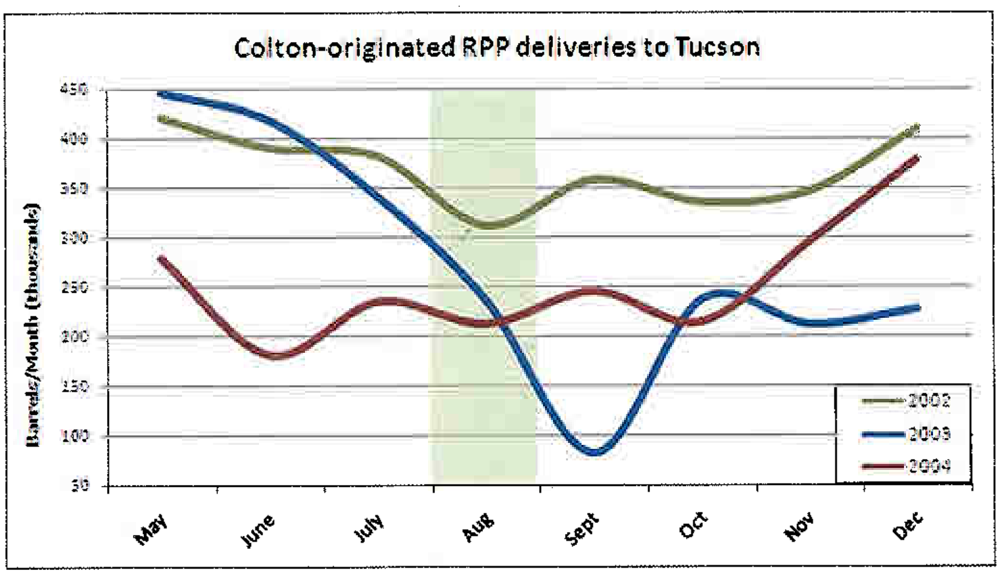

Figure 12: Colton-originated RPP deliveries to Tucson.[19]

[18] (J. Kadnar, unpublished data)
[19] Ibid.

Figure 13 shows cumulative deliveries to Tucson from both Colton and El Paso-originating supplies. These graphs show data for the years preceding and succeeding the failure to determine whether the post-rupture shortages were real or perceived. The graph clearly illustrates that there was no real shortage.

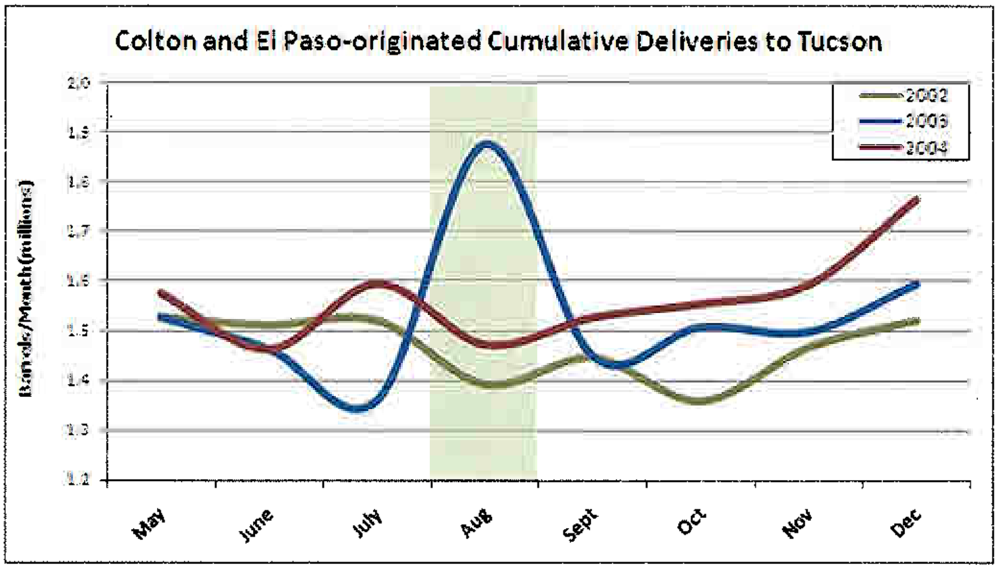

Figure 13: Colton and El Paso-originated cumulative deliveries to Tucson.[20]

Since the accident occurred on July 30th, flow figures for August are key. For August 2003, KM supplied Tucson with almost 500,000 barrels more than they did during the same period in 2002, and nearly 400,000 barrels more than 2004. Data from 2002 and 2004 illustrates a typical slight dip in consumption as opposed to July and September. In September 2003, KM supplied Tucson with RPPs equivalent to supplies the previous year.

[20] Ibid.

Figures 14 -16 show RPP flows into Phoenix. Since the failure occurred on the line between Tucson and Phoenix, KM had to make up its losses by bringing in more product from Colton.

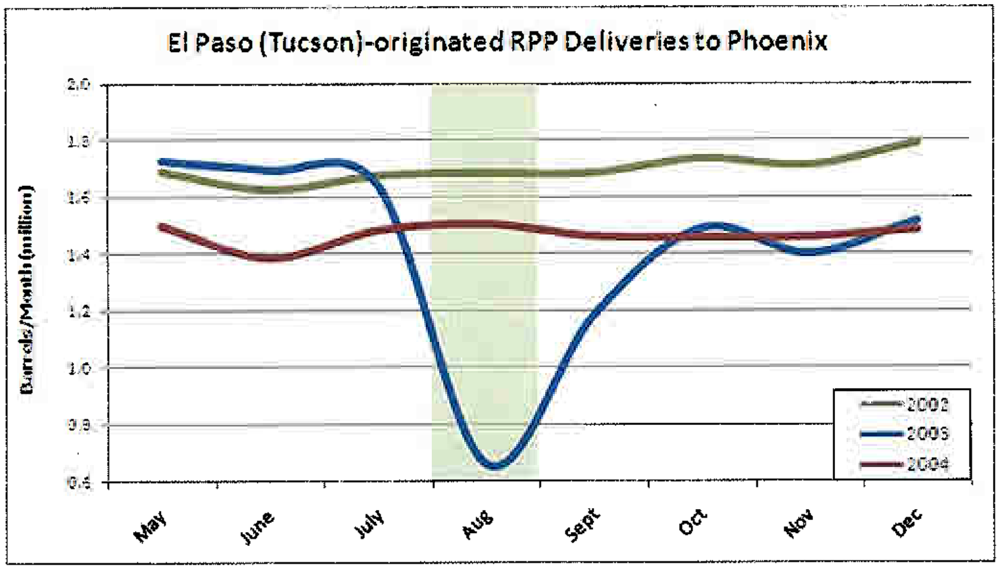

Figure 14: El Paso (Tucson)-originated RPP deliveries to Phoenix.[21]

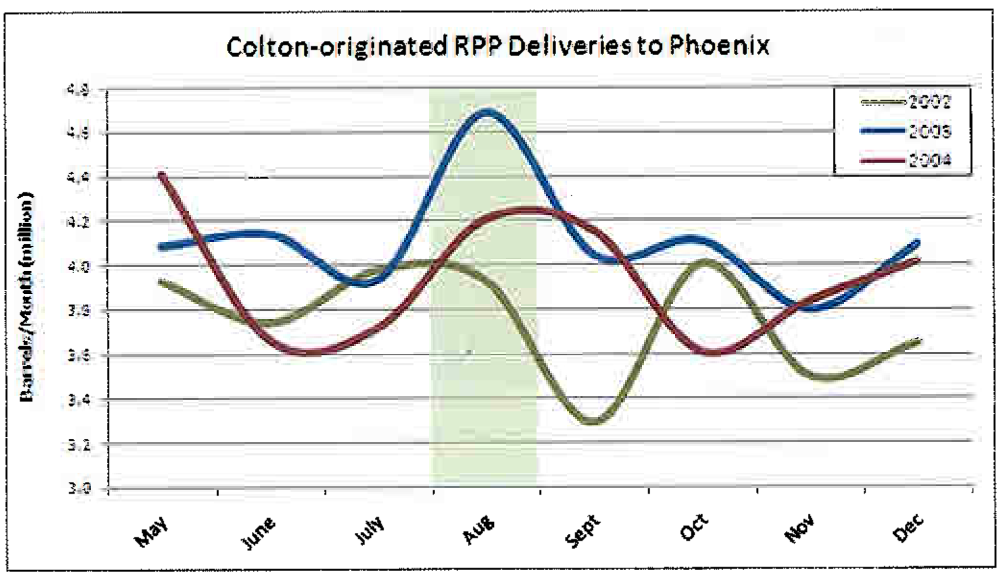

Figure 15: Colton-originated RPP deliveries to Phoenix.[22]

[21] Ibid.
[22] Ibid.

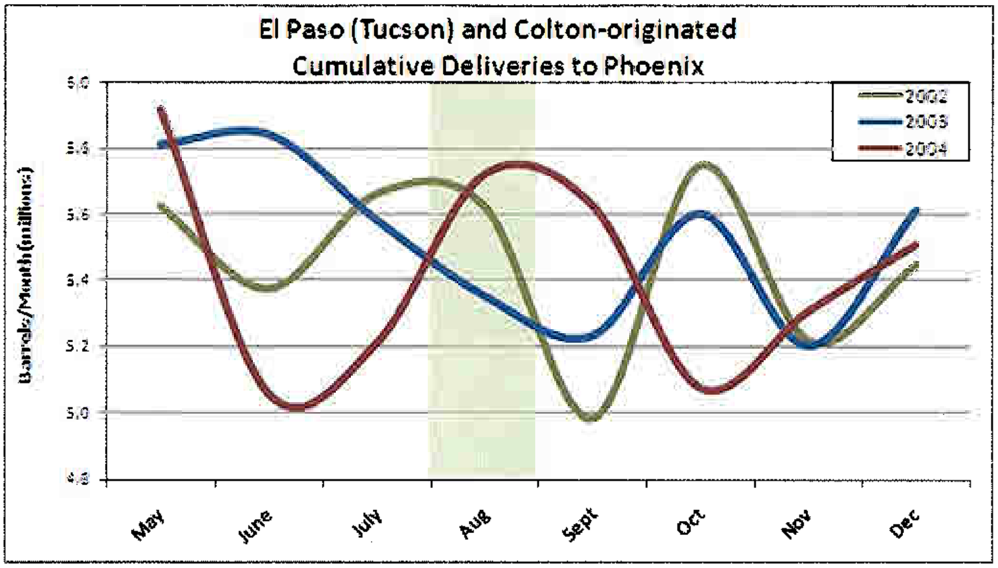

Figure 16: El Paso (Tucson) and Colton-originated cumulative deliveries to Phoenix.[23]

In August 2003, KM delivered almost 200,000 barrels less than they did in August 2002 and almost 300,000 barrels less than they did in August 2004. Using more robust statistical techniques (chi square) to test for significance, DOT concluded that August 2003 was not statistically different from the other months at the 95% level. In other words, there were no significant differences by year, or by month, at a high level of statistical certainty.

As mentioned earlier in this report, different localities in the U.S. require—for purposes of reducing pollution—different boutique fuel blends for gasoline. Managing boutique fuels during supply crunches is always difficult.

Both Phoenix and Tucson had started using CBG in 2003. During the initial days of the supply disruption, gasoline readily available in Tucson, Las Vegas, and Imperial, California could not be delivered to Phoenix because it did not meet prevailing CBG specifications for Phoenix.

[23] Ibid.

We also assessed gasoline stocks in Arizona. Figure 17 shows how these stocks varied in the May-to-December period for 2002-2004.

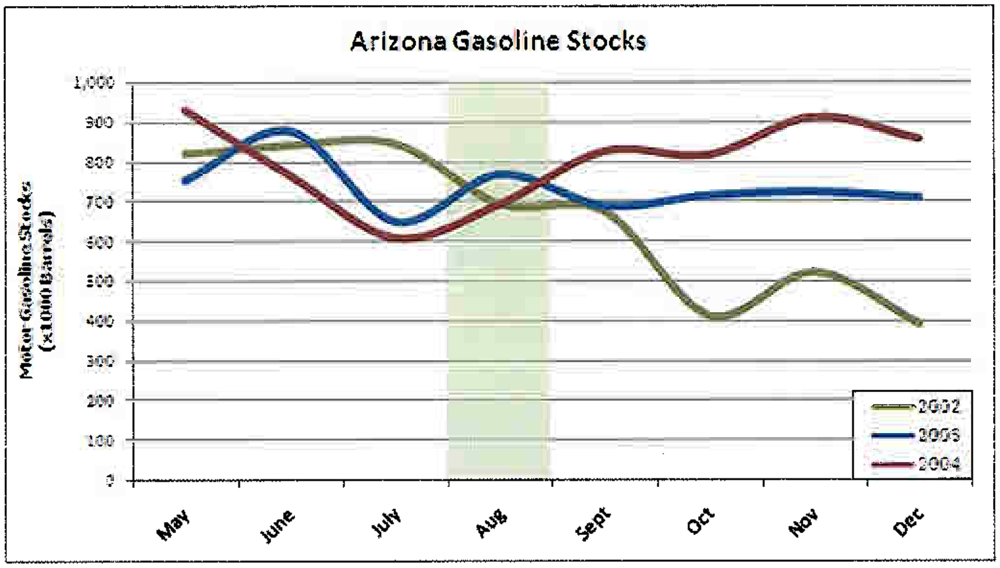

Figure 17: Arizona gasoline stocks.[24]

Arizona had about 100,000 barrels more motor gasoline stocks in August 2003 than in August 2002. More importantly, these data also show Arizona's stocks from September through December in 2003, after the accident in Tucson, exceeded 2002's stocks for the same period by more than 200,000 barrels, on average. This is significant because it demonstrates KM's ability to manage the demands and expectations placed on its pipeline system by the consumer, shipper and marketer.

Actions undertaken by KM included the following:

- KM made tank and rack modifications in Tucson, so the CBG in the pipeline (between El Paso and Tucson) could be trucked to Phoenix. However, due to the limited number of hours that truck drivers could work under DOT regulation, trucking the boutique fuel to Phoenix was a daunting task.
- Concurrent with the tank and rack modifications, KM also shut down a parallel pipeline that ran from Phoenix to Tucson and modified it to deliver product in the opposite direction, from Tucson to Phoenix. This alleviated the congestion at the Tucson rack for Phoenix CBG.
- Transport of product to retail stations was carried out by KM's customers, the owners of the product. KM converted facilities and made those facilities available to their customers to pickup CBG.
- In addition to the work at Tucson, KM modified its operation to transport additional CBG to Phoenix from Colton. The data in the above figures show that West Coast refiners ramped up their production of Phoenix-bound CBG to meet the sudden market demand.

[24] Ibid.

These adjustments and adaptations, combined with a waiver allowing truck drivers to temporarily exceed their usual maximum number-of-hours-worked, alleviated effects of the supply disruption at multiple points along the supply chain and helped remedy the situation.

Following the Tucson event, KM reconfigured and installed new pipeline facilities. The initial expansion project was completed and placed into service in June 2006. The final expansion project was completed and commenced service in January 2008.

Reflecting back on the Tucson rupture and its associated events, it seems clear that while the rupture reduced supply, flows from the west nearly made up for the loss. A "run" on fuel, rather than diminished pipeline performance, accounted for much of the apparent supply disruption.

Case Study 2: Florida's Gasoline Stocks and Prices During the 2004 Hurricane Season

Case study key takeaways

- Even with no interstate pipelines and few intrastate pipelines, Floridians pay less for gasoline, on average, than other Americans.
- After being battered by hurricanes in 2004, Floridians did not pay higher prices at the pump.
- Florida appears to have large and stable gasoline stocks.
- Marine imports and inland tanker trucks serve Florida well.

Overview

Florida ranks fourth in the nation for population, and third in gasoline consumption, yet there are no interstate RPP pipelines supplying the state. All RPPs coming into Florida do so via marine tanker, and are then distributed throughout the state through intrastate pipelines or tanker truck.

Florida's eight intrastate pipelines total just 370 miles in length. Of these, the pipeline operated by Central Florida Pipeline Company is the longest, at 203 miles. It serves markets from Tampa to Orlando. The next longest, at thirty-five miles, is operated by Everglades Pipeline Company, and serves International Airport from Port Everglades.

The eleven-mile Tampa Pipeline serves Tampa International Airport and the one-mile CITGO pipeline serves Ft. Lauderdale Airport. The remaining four pipelines serve local markets or power plants.

The Hurricanes of 2004

During August and September, 2004, Florida was struck by a devastating series of storms and hurricanes. Bonnie, a relatively small tropical storm, made landfall on August 12th , just south of Apalachicola. Bonnie was quickly followed by Hurricanes:

- Charley (August 13th, Category 4)
- Frances (September 5, Category 2)
- Ivan (September 16, Category 3)
- Jeanne (September 25th, Category 3)

Hurricanes Charley, Frances and Jeanne battered Florida's population centers, including Tampa and Orlando. Hurricane Ivan slammed the state's tourist region along the Florida Panhandle.

Figure 18 illustrates the paths of the hurricanes and the counties that absorbed their impact.

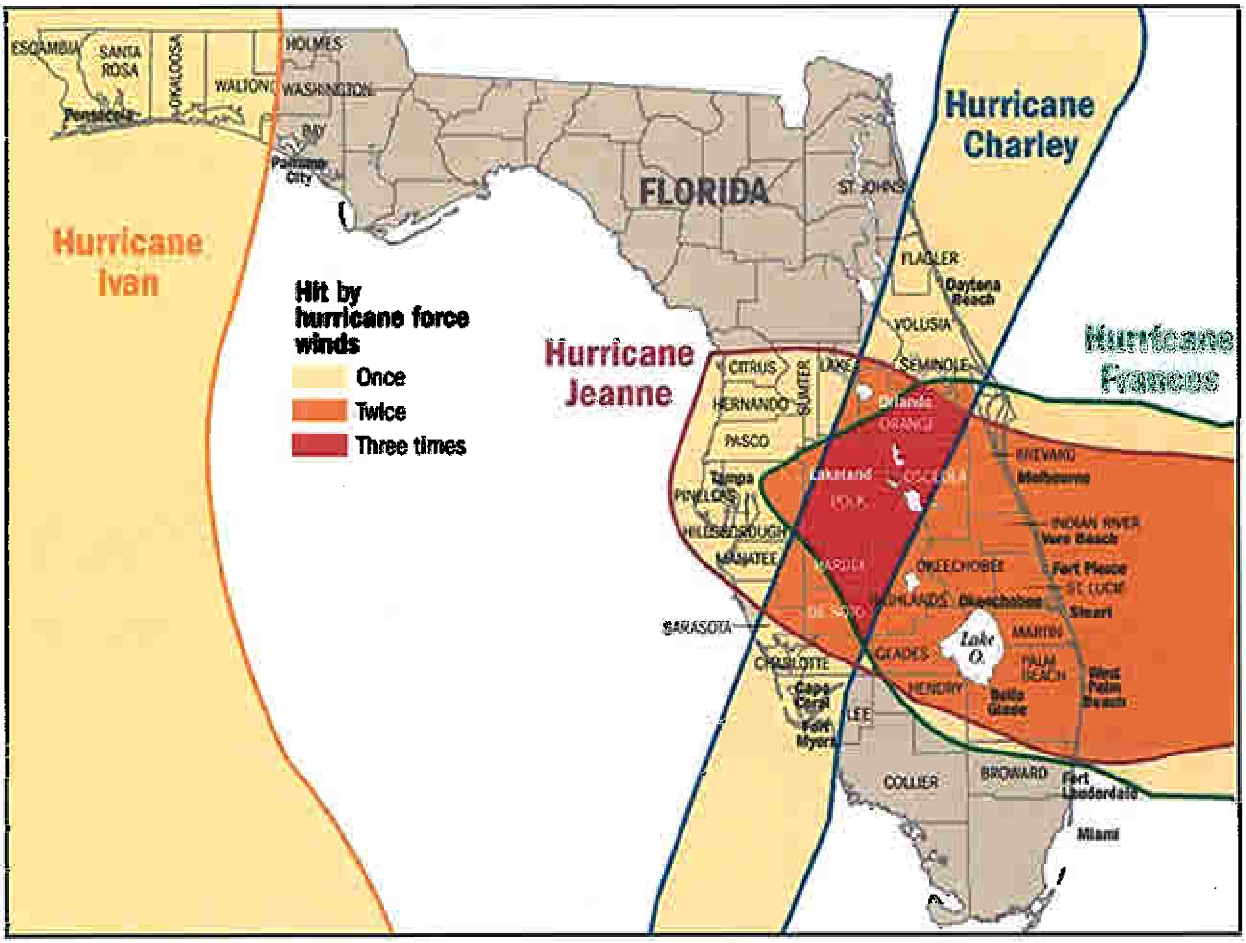

Figure 18: Florida counties exposed to hurricanes, August-September 2004.[25]

[25] National Weather Service/National Hurricane Center, http://g2.palmbeachpost.com/storm/content/weather/special/storm/2004/atlantic/

Effect on Supplies

As illustrated in Figure 19, Florida's gasoline stocks averaged 4.6 million barrels from January 2003 through February 2008. The highest stock level, 6.3 million barrels, occurred in July 2007; the lowest recorded stock level occurred in February 2004, at 3.2 million barrels.

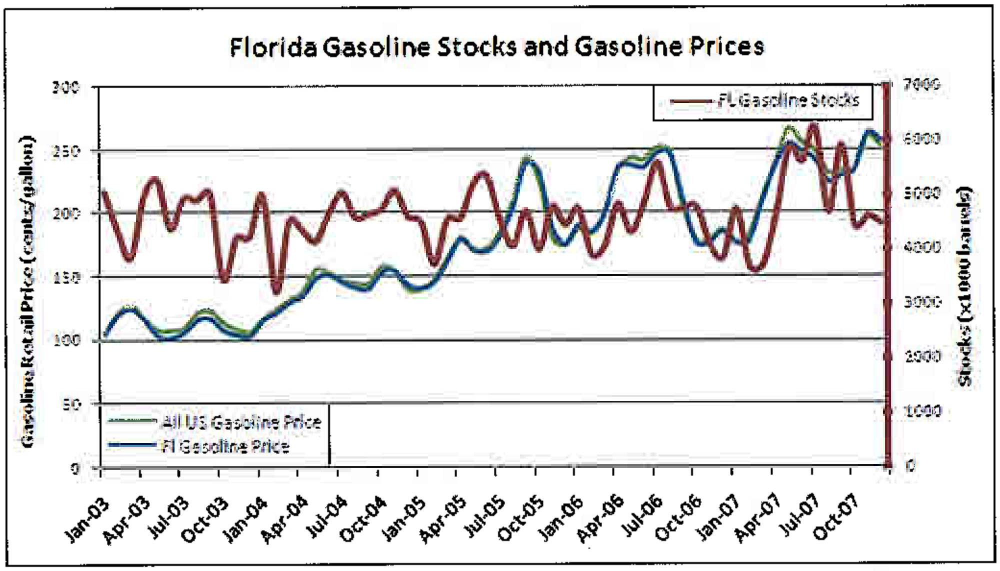

Figure 19: Florida gasoline stocks and gasoline prices, January 2003 - October 2007.[26]

Florida's average stock level during the 2004 hurricane season was 4.8 million barrels, slightly higher than the average level for the 62-month period graphed in Figure 19.

Our analyses reveal that Florida consumers have, on average, paid 1.78 cents less than the rest of the United States for gasoline. Surprisingly, this price advantage actually increased during the 2004 hurricane season, when Floridians paid 2.1 cents less.

Over the 62 months examined, the least that Florida consumers paid in comparison with the U.S average was recorded in May 2007, at -12.3 cents. The greatest price premium paid by Florida motorists was during November 2005, coming in at 8 cents over the average price paid across the country.

Florida demonstrates that large markets on coastlines can be adequately served even in the absence of pipelines.

Case Study 3: Hurricanes Katrina and Rita

Case study key takeaways

- Pipelines can be repaired and returned to service quickly.
- Both oil and RPP spot prices surged after Hurricane Katrina, but moderated soon thereafter.
- Hurricane Rita had some effect on spot RPP prices, but little or none on spot oil prices.

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[26] (J. Kadnar, unpublished data)

- Low-sulfur diesel prices increased only along the Gulf Coast and stabilized quickly.
- Retail gasoline prices along the Mid-Atlantic and Southeast coasts are correlated with pipeline movements from the Gulf coast to the East Coast. Although pipeline movements from the Gulf coast to the East coast were 15% lower from September through November 2005, the price spikes cannot be attributed to the pipeline disruptions.
- RPP storage capacity is critical during natural disasters, because it serves to dampen price fluctuations. In the years leading up to Hurricanes Katrina and Rita, storage inventories had diminished, and this sharpened the effects of the hurricanes on prices.
- The federal government should encourage and work with industry to assess oil and RPP inventories in order to protect against extreme price fluctuations that may occur due to natural disasters.

Overview

The Gulf of Mexico is one of the largest oil and gas production areas in the world. The coastlines of Texas, Louisiana and Mississippi are dotted with ports, oil refineries and storage terminals. Pipelines connect these facilities to each other, while other pipelines extend outward from the Gulf Coast, transporting oil and RPPs to the rest of the United States.

Hurricane Katrina made landfall on August 29, 2005, and resulted in the shutdown of most oil and natural gas production in the Gulf of Mexico, as well as a great deal of refining capacity in Louisiana and Alabama. Rita struck on September 24th and compounded these production and refining losses.

In combination, the two hurricanes shut down 1.3 million bbl/d, or about 8%, of America's refining capacity.

Effects on Gasoline Prices

On the eve of Hurricane Katrina, there were few cushions against adverse supply developments. For the week ending August 26th, three days before landfall, refiners were operating at 97% capacity and gasoline stocks were at twelve million barrels, nearly 6% below year-earlier levels.

Without a cushion of spare capacity or high inventories, only price could balance demand with suddenly-lower supply after Katrina struck. Prices rose sharply, discouraging demand and acting as a magnet for new supply.

Despite ongoing, substantial oil and gas production losses, the immediate surges in gasoline prices dissipated within a few weeks.

Figure 20 shows May-December 2005 oil spot prices for West Texas Intermediate oil and conventional gasoline destined for the New York, the U.S. Gulf Coast and Los Angeles, California.

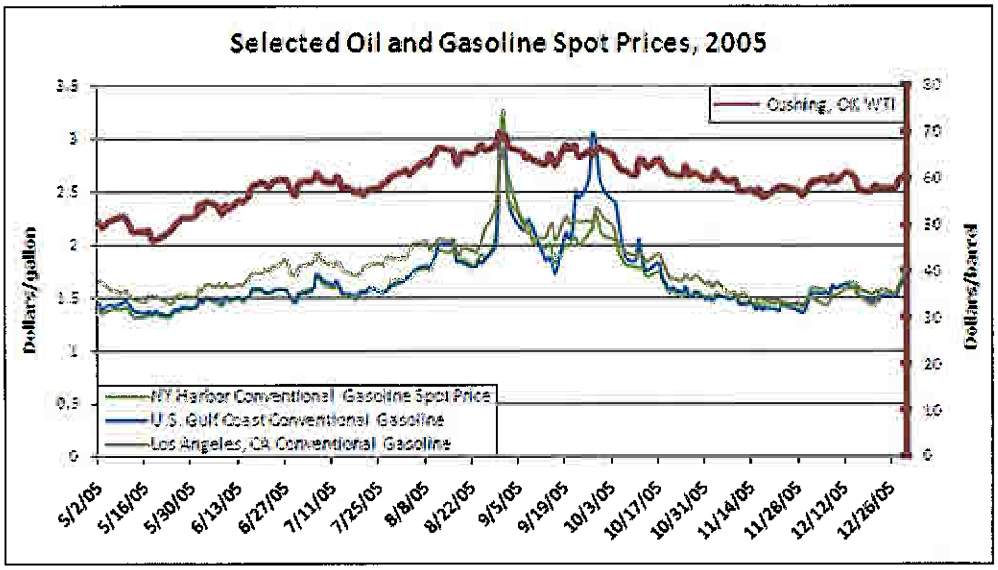

Figure 20: Selected oil and gasoline spot prices, 2005.[27]

We also looked at retail gasoline prices along the East Coast during hurricane seasons from 2003 to 2008. Prices were significantly correlated ($p<0.001$) with each other and with the broader U.S. gasoline price. Therefore, for the rest of our analyses, we compared with the U.S. gasoline price.

In a regression model with price as the outcome, the inverse movement of gasoline from the Gulf Coast to the East Coast and year are the only two independent significant variables with an adjusted R-square value of 82%.

[27] Ibid.

Figure 21 shows pipeline gasoline movements from the Gulf Coast to the East Coast. Gasoline movements are relatively constant at 77 million barrels per month (bbl/m) from May through August after which they plunged to approximately 63 million bbl/m in September, corresponding to the hurricane's timeframe (as shown by the black curve which corresponds with the right-hand-side y-axis). It wasn't until December that gasoline movements via pipeline to the East Coast approached normal.

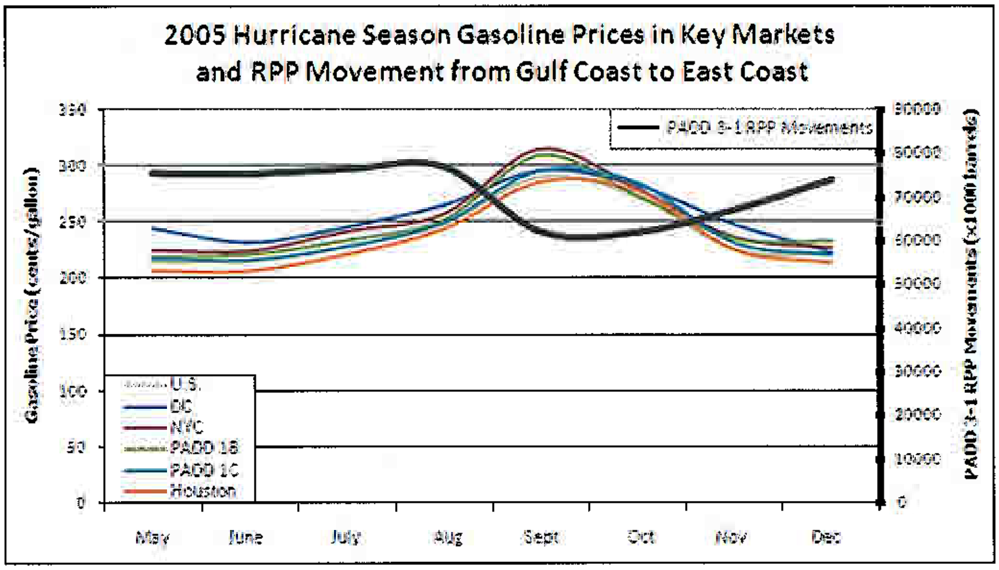

Figure 21: 2005 hurricane season gasoline prices in key markets, and RPP movement from the Gulf Coast to East Coast.[28]

Gasoline prices along the East Coast, and in Houston and Chicago, however, started trending upwards in June in response to the summer driving season. They peaked at the same time gasoline movements declined.

A series of pump stations lost power on August 29th, 2005, and the federal government and private sector restored their power the following day. Thereafter, pipeline utilization rates increased incrementally. On September 1st, one pipeline company reached full utilization. Another company, operating two pipelines, reached full utilization on September 4th.

[28] Ibid.

Figure 22 illustrates the two pipeline companies' utilization rates after power was secured and the pump stations restarted.

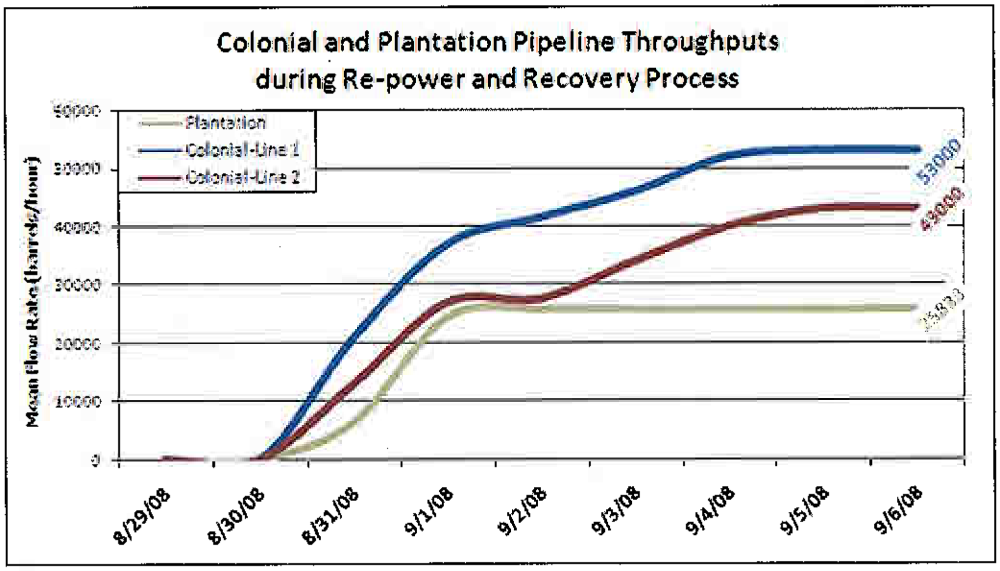

Figure 22: Colonial and Plantation pipeline throughputs during re-power and recovery process.[29]

We conclude from this discussion that gasoline prices, although correlated with movements, did not increase solely because of reduced pipeline utilization; the pipelines were fully operational within five days after electrical power was lost, and a number of other factors came into play:

- Pipeline utilizations were diminished through November because of refinery losses.
- Hurricanes Katrina and Rita damaged port facilities along the Gulf Coast and this reduced overseas imports.
- Both hurricanes damaged production facilities in the Gulf of Mexico, so Gulf Coast refineries experienced an uneven ramp-up of refining capacity.

It is also important to remember that pipeline companies do not own the energy products they transport. Shippers and marketers own the products, and make their own decisions. The behavior of shippers and marketers during this timeframe are outside the scope of our analysis.

EFFECT ON SUPPLIES

In the case of oil, the effects of production and refinery capacity losses were first contained and then ameliorated by a combination of all-out effort by industry, and timely, market-supporting government action. Industry response included intensified efforts to increase supply from undamaged domestic sources, shopping the world market for additional supply and moving product to where it was most needed.

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29 Ibid.

The federal government moved promptly to tap the Strategic Petroleum Reserve (SPR), announcing the first loans of SPR oil on September 1, 2005. The next day, a presidential finding described "a severe energy supply interruption" and authorized the sale of an additional 30 million barrels of SPR oil.

U.S. federal action was part of a coordinated action announced the same day by the International Energy Agency to make 60 million barrels of oil and RPPs available on world markets. Regulatory barriers were also eased to expedite free movement of these products.

These concerted strategies were successful. Oil prices rose only modestly above pre-Katrina levels and quickly retreated.

Movements in oil prices were relatively small, both in the run-up and the aftermath of both hurricanes. In mid-August, West Texas Intermediate (WTI) prices were already averaging about 150 to 160 cents/gallon (about $65/barrel). Prices moved to a peak of 166 cents/gallon ($70/barrel) immediately after Katrina made landfall, but then eased back. Rita had even less impact on oil prices, and within the first week of October, oil prices had fallen below pre-Katrina levels.

Two factors account for the subdued price response: first, oil production losses were accompanied by losses in refiners' capability to use the oil, and second, the Administration made it clear that oil from the SPR would be freed up and made available to refiners and to the broader markets as required.

Also following the hurricanes, RPP supplies were buttressed by the release of thirty million barrels of gasoline, middle distillate and other products from the strategic reserves of member nations of the Organization for Economic Cooperation and Development. Ever since those barrels arrived in early fall 2005, the global private sector has provided the United States with an increased level of imports, and supply appears to have matched demand, as RPP prices trended downward in late 2005 and early 2006.

Case Study 4: 2006 BP Pipeline Accidents in Alaska

Case study key takeaways

- The BP accidents in Alaska did not cause West Coast gasoline prices to increase much above that which can be attributed to normal market fluctuations.
- West Coast gasoline stocks did not experience large shifts due to the accidents, because refiners acquired oil from other sources.
- The West Coast gasoline market is largely integrated; supply/demand/price events in one state ripple across the others. At the same time, each state has individual attributes that tend to raise gasoline prices, such as use of boutique blends in California; lack of refining facilities and supply options in Oregon; environmental regulations; state-specific labor laws, etc.

Overview

On March 2, 2006, a 34-inch oil pipeline operated by BP Exploration (Alaska) Inc. (BP) in Prudhoe Bay, Alaska, developed a leak caused by internal corrosion. The pipeline, located in BP's Western Operating Area (WOA), feeds crude oil to the Trans-Alaska Pipeline System for transport to the marine terminal at the Port of Valdez. From Valdez, the oil is delivered to West Coast refineries.

As soon as BP discovered the leak, they shut down the pipeline and commenced clean-up and remediation. The company estimated that the leak spilled 5000 barrels of crude oil.

Prior to the shutdown, total production from BP's Prudhoe Bay operation was in excess of 400,000 bbl/d. The shutdown resulted in the loss of 90,000 bbl/d of production. BP installed a new pipeline section to circumvent the leak, which restored some 72,000 bbl/d of production.

On August 5, 2006, BP discovered another leak caused by internal corrosion, this one in their Eastern Operating Area (EOA). BP shut down the EOA the following day, and notified DOT of their intention to completely shut down both the WOA and EOA pipelines. BP's smaller-diameter Lisburne pipeline would continue to operate.

Cessation of flow through the WOA and EOA pipelines would remove approximately 340,000 bbl/d of production from the Alaska North Slope, or almost 40% of the total volume of oil transported by the TAPS. Moreover, this also meant that West Coast refineries would experience a significant shortfall of crude oil supply.

Three days later, on August 8th, BP reversed their decision to shut down the WOA, but proceeded to complete shutdown operations of the EOA, taking 160,000 bbl/d out of production.

During the August-November 2006 timeframe, BP conducted comprehensive evaluations of their pipelines to detect and minimize potential for other accidents that would impede operations.

In early November, the company resumed operations, and on November 4, 2006, BP reported production of 427,000 bbl/d, with oil production at 366,000 bbl/d and the rest comprised of natural gas liquids. The breakdown of oil volumes flowing through the individual lines were reported as:

- 191,000 bbl/d delivered by the WOA pipeline
- 156,000 bbl/d delivered by the EOA pipeline
- 19,000 bbl/d delivered by the Lisburne pipeline section

The following year, on August 6, 2007, a fire at BP's facilities on the North Slope caused a 5,000 bbl/d loss of production until repairs were accomplished. On October 6th, another fire reduced production in the WOA by 30,000 bbl/d.

Effects on Supplies

We examined this case to evaluate the repercussions of these events on West Coast refineries, the primary consumers of Alaskan oil shipments. We examined two indicators, West Coast gasoline prices compared with nationwide prices, and West Coast gasoline stocks.

West Coast gasoline prices

Figure 23 shows several curves running from January 2005 through December 2007:

- average U.S. retail gasoline prices
- Washington, Oregon and California retail gasoline prices (broken out)
- West Coast (average) gasoline prices

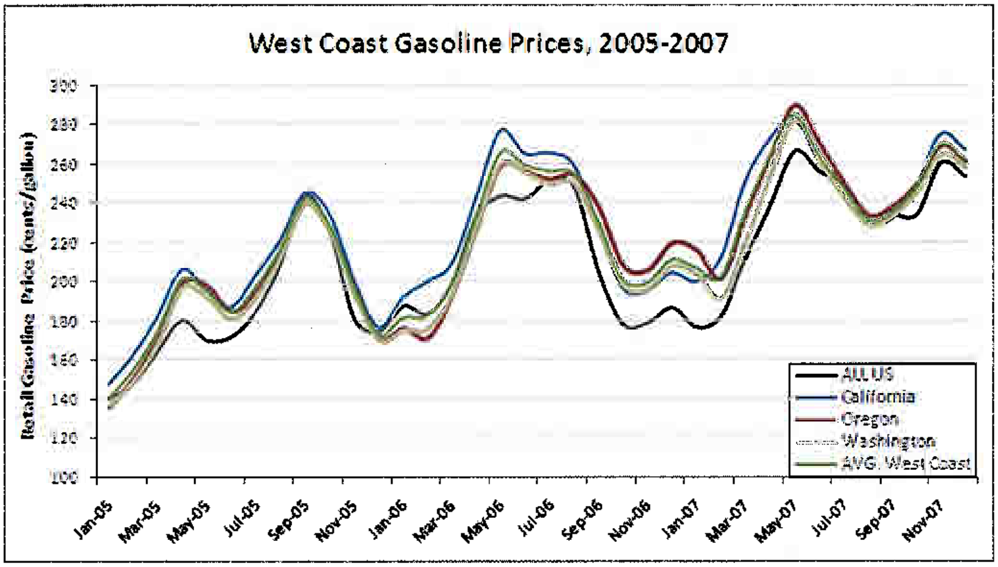

Figure 23: West Coast gasoline prices, January 2005 – December 2007.[30]

The shapes of these curves are similar. Typically, the West Coast pays about 11 cents more per gallon for gasoline, when compared with the national average price.

Over the 36-month period illustrated in Figure 23, the lowest price paid on the West Coast during this timeframe was -6.2 cents below the national average, in January 2006. The highest was 30.1 cents above the national average, in January 2007.

From March through November 2006, when BP's pipelines and associated facilities experienced the leaks and fires described above, the highest price premium paid by West Coast motorists came in at 25.73 cents above the national average, in September 2006; the lowest, 0.13 cents below the national average, occurred in April 2006; and motorists paid an average premium of 13.30.

[30] Ibid.

West Coast gasoline stocks

The second indicator we evaluated was gasoline stocks in California, Oregon and Washington. Figure 24 illustrates the fluctuations in those stocks from January 2005 to April 2008.

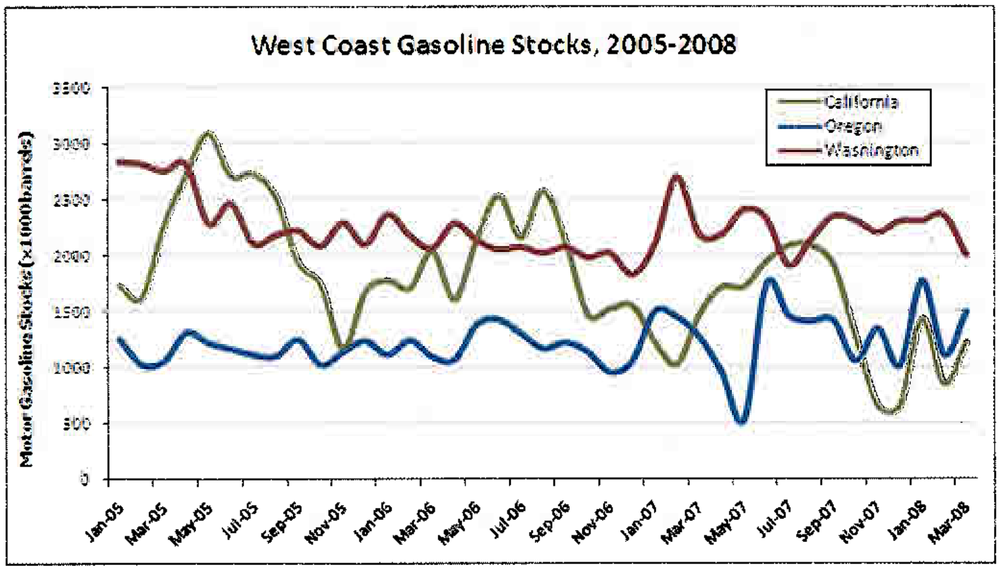

Figure 24: West Coast gasoline stocks, January 2005 - April 2008.[31]

Oregon and Washington's stocks were relatively stable during the study period, at 1.2 million barrels for Oregon and 2.3 million for Washington. California's stocks, on the other hand, vary significantly from a high of 3.1 million barrels in May 2005, to a low of 0.65 million in December 2007.

Gasoline stocks in California during the BP events in Alaska (March through November 2006) were about 10% higher than the overall study period average. Oregon and Washington's stocks, on the other hand were lower; Oregon's by almost 3%, and Washington's by about 8%.

[31] Ibid.

SECTION FIVE: HURRICANE SEASON OIL AND RPP MOVEMENTS AMONG REGIONS

SECTION-AT-A-GLANCE

- Pipeline "capacity" does not have a universally accepted definition, and different entities represent it differently.
- Pipeline capacity or utilization is not homogenous in pipeline sections.
- The Top-20 oil, RPP and LPG pipeline systems move approximately 40% of their respective commodities in the U.S.
- The East Coast is the largest beneficiary of Gulf Coast RPPs, while the Midwest is the largest beneficiary of Gulf Coast oil shipments.

OPPORTUNITY FOR ANALYSIS

Our examination of the dramatic hurricane season of 2005 presented clear insights into pipeline movements between PADD regions, and prompted a broader examination, and comparison, of inter-PADD movements across multiple (and more-ordinary) years.

No hurricanes made landfall along the Gulf Coast or struck Gulf of Mexico oil-producing areas in 2006 and 2007, so we had an opportunity to analyze dynamics of commodity movements across a broad set of conditions.

ELEMENTS OF ANALYSIS

We looked at inter-PADD pipeline transport for eight different dynamics:

1. Oil movements from the Gulf Coast to the Midwest
2. RPP movements from the Gulf Coast to the Midwest
3. RPP movements from the Gulf Coast to the East Coast
4. Oil movements from the Rocky Mountains to the Gulf Coast
5. RPP movements from the Gulf Coast to the West Coast
6. RPP movements from the Rocky Mountains to the West Coast
7. Oil movements from the Rocky Mountains to the Midwest
8. RPP movements from the East Coast to the Midwest

To fully illustrate the dynamics of RPP movements, we also evaluated gasoline stocks in selected states. As mentioned previously, RPP storage serves as a "strategic reserve" for local markets. During supply disruptions, storage can augment supplies and enable deliveries downstream.

We analyzed gasoline stocks in Texas, Louisiana, Georgia, South Carolina, North Carolina, Virginia, New Jersey and New York. Texas and Louisiana were treated as one cluster along the Gulf Coast; Georgia, the Carolinas and Virginia were treated as the Mid-Atlantic cluster; and New Jersey and New York were treated as the Northeast cluster. These analyses were done for the May-December period from 2002 to 2007.

Much has been written about the failure of the electrical grid due to Katrina. Power losses disabled pump stations on two pipelines operated by Colonial Pipeline Company and one operated by Plantation Pipeline Company. These lines deliver RPP from the Gulf Coast through the South and Mid-Atlantic regions into the Northeast. Therefore, we also looked at the actions taken by Colonial and Plantation to resume their pipeline deliveries.

We include information on the "shoulder months" of May and December, one on either side of the hurricane season, to better extract trends in oil deliveries across regions. By including May, we also catch the peak driving season, which typically begins in May. In December, shippers and marketers move products into storage in preparation for the winter heating season.

General Response of Pipeline Operators to Increased Volumes

It is worth noting that our overall examination of oil and RPP movements in recent years, along with anecdotal evidence, suggests that pipeline operators have adjusted their strategies and accommodated increasing volumes of liquid energy products by:

- investing in research and development to manage reliability
- managing supply chains for just-in-time deliveries
- introducing tools to detect flaws that could cause temporary disruptions
- building new infrastructure where necessary
- upgrading pipeline assets by, for example, relieving bottlenecks to improve flow characteristics
- installing new pump stations or increasing the horsepower of existing pumps to enhance throughput

SCENARIO 1: HURRICANE SEASON OIL MOVEMENTS FROM THE GULF COAST TO THE MIDWEST (PADD 3 to 2)

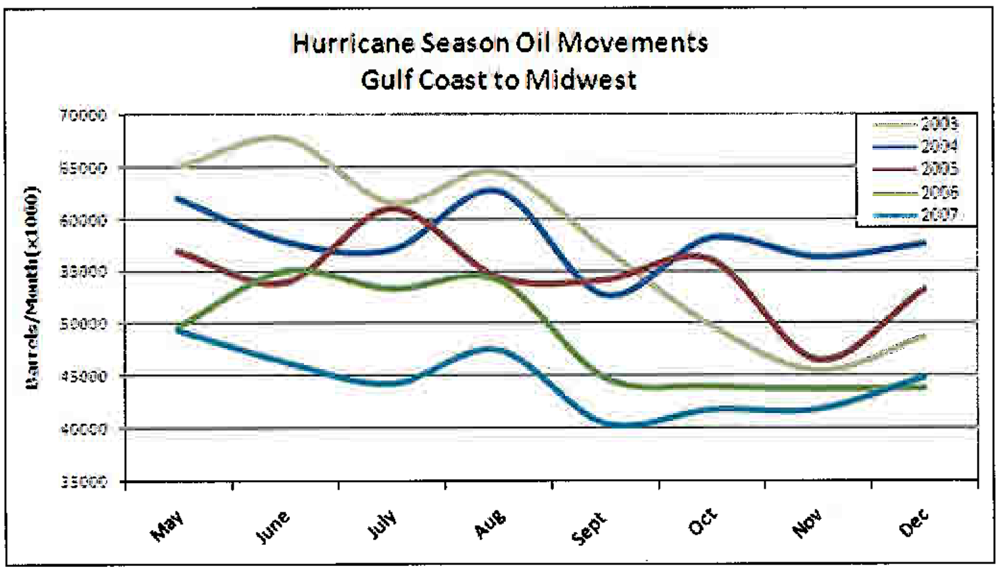

Figure 25: Hurricane season oil movements from the Gulf Coast to the Midwest, 2003-2007.[32]

Figure 25 shows the oil movements from the Gulf Coast to the Midwest, between May and December, for 2003-2007.

One would have expected trends in 2006 and 2007 to be starkly different from our findings. Because there were no hurricanes, there were no disruptions to production, and therefore one would expect more oil to be moving toward the Midwest. But the data shows that the Midwest is becoming less dependent on oil from the Gulf Coast. There could be two reasons for this: either Midwest refineries are getting more oil from Canada, or more product is moving from the East Coast to the Midwest.

Typically, there is an upward swing in oil movements to the Midwest that peaks in August. This is followed by a dip in the fall—corresponding to the end of the summer driving season—and a stabilization of Midwest imports from the Gulf Coast.

In 2005, however, the upward swing is absent because of Katrina and Rita's effect on shipping channels and on electrical power supplies. By October 2005, however, it appears that oil movements via pipeline

[32] (J. Kadnar, unpublished data)

had settled. The dip in November may have occurred because refineries in the Midwest were adequately stocked with oil.

Scenario 2: Hurricane Season RPP Movements from the Gulf Coast to the Midwest (PADD 3-2)

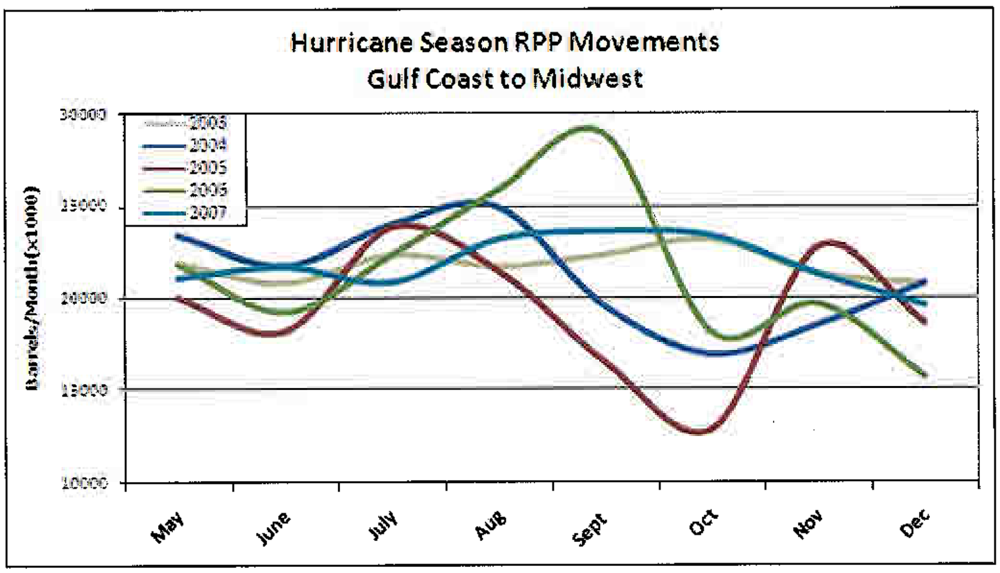

Figure 26: Hurricane season RPP movements from the Gulf Coast to the Midwest, 2003-2007.[33]

Figure 26 shows RPP movements from the Gulf Coast to the Midwest, between May and December, for 2003-2007.

This graph illustrates an interesting decrease in RPP movement from August through October, 2004. Because the hurricane season of 2005 was so destructive, many have forgotten that 2004 was also an active hurricane season. Like Rita, Hurricane Ivan affected production in the Gulf of Mexico, and refineries did not operate at capacity.

It also appears that the Midwest—perhaps having learned from the 2005 season and fearing another difficult hurricane season—began in June of 2006 to increase RPP imports.

The 2006 season proved benign, however, and after September the Midwest ceased its import ramp-ups.

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[33] Ibid.

Scenario 3: Hurricane Season RPP Movements from the Gulf Coast to the East Coast (PADD 3 to 1)

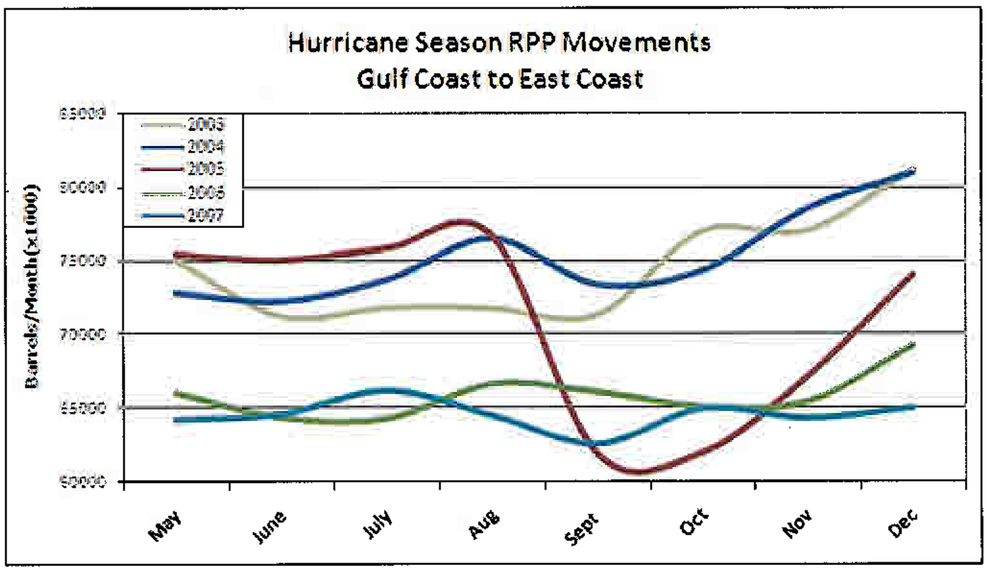


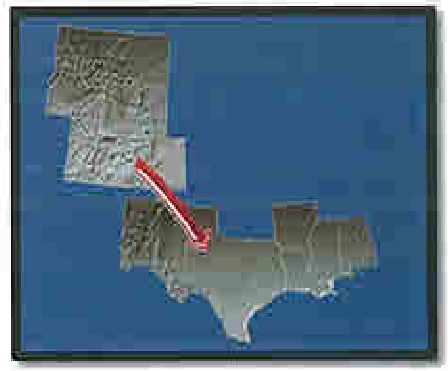
Figure 27: Hurricane season RPP movements from the Gulf Coast to the East Coast, 2003-2007.[34]

Figure 27 is telling in three areas:

- First, RPP exports from the Gulf Coast to the East Coast tend to be stable throughout the year.
- Second, the effects of Hurricane Katrina are clearly evident in their timeframe, with exports dropping by almost fifteen million bbl/m. Thereafter, pipeline operators ramped up exports to the East Coast, and by mid-December of 2005, flows approached pre-hurricane levels.
- Third, in 2006/2007 the Gulf Coast exported nearly ten million fewer bbl/m of RPPs to the East Coast than during 2003/2004. This drop-off may reflect changes in East Coast consumption patterns. A second explanation is that overseas imports to the East Coast have become more competitive with Gulf Coast supplies.

[34] Ibid.

SCENARIO 4: HURRICANE SEASON OIL MOVEMENTS FROM THE ROCKY MOUNTAINS TO THE GULF COAST (PADD 4 to 3)



The Gulf Coast has historically imported a relatively small amount of oil from the Rocky Mountains region, usually about 200,000 bbl/m. After Hurricane Katrina that number nearly doubled, however, to almost 400,000 bbl/m (Figure 28).

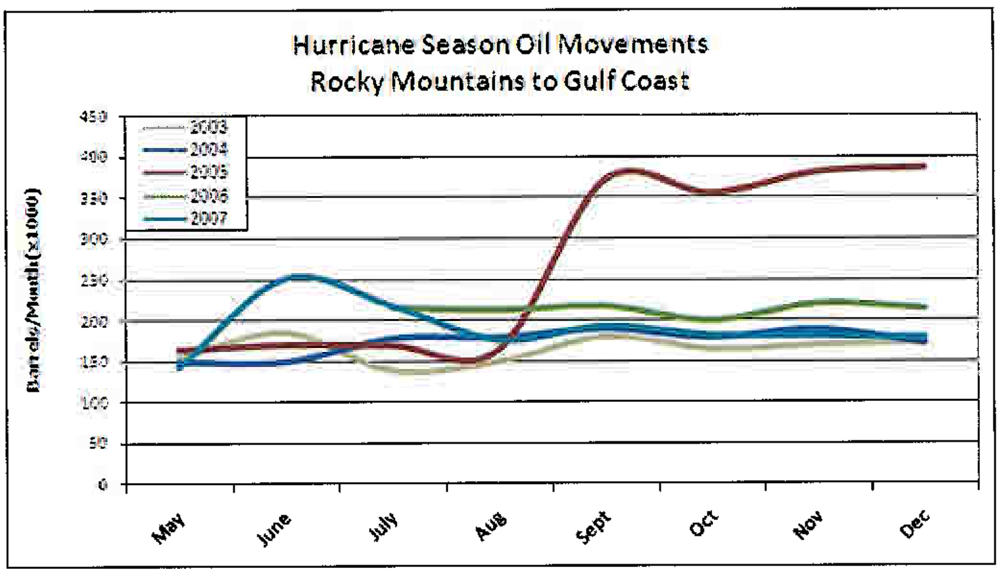


Figure 28: Hurricane season oil movements from the Rocky Mountains to the Gulf Coast, 2003-2007.[35]

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[35] Ibid.

SCENARIO 5: HURRICANE SEASON RPP MOVEMENTS FROM THE GULF COAST TO THE WEST COAST (PADD 3 to 5)

Over the past two decades the West Coast also received an average 2.3 million bbl/m of RPPs from the Gulf Coast. These Gulf Coast RPPs flow through the Kinder Morgan Energy Partners' pipeline system, which terminates in Phoenix, Arizona.

Loss of refining capacity and disruption of shipping channels in the Katrina-Rita timeframe did not materially affect the Gulf Coast's ability to export products to the West Coast. Exports were relatively consistent, at about 2.7 million bbl/m for the May-December period from 2003-2005 (Figure 29).

The next two years portray a different story; in 2006 the West Coast received about 3.7 million bbl/m from the Gulf Coast, and in 2007 this number increased to an average of 4.4 million bbl/m.

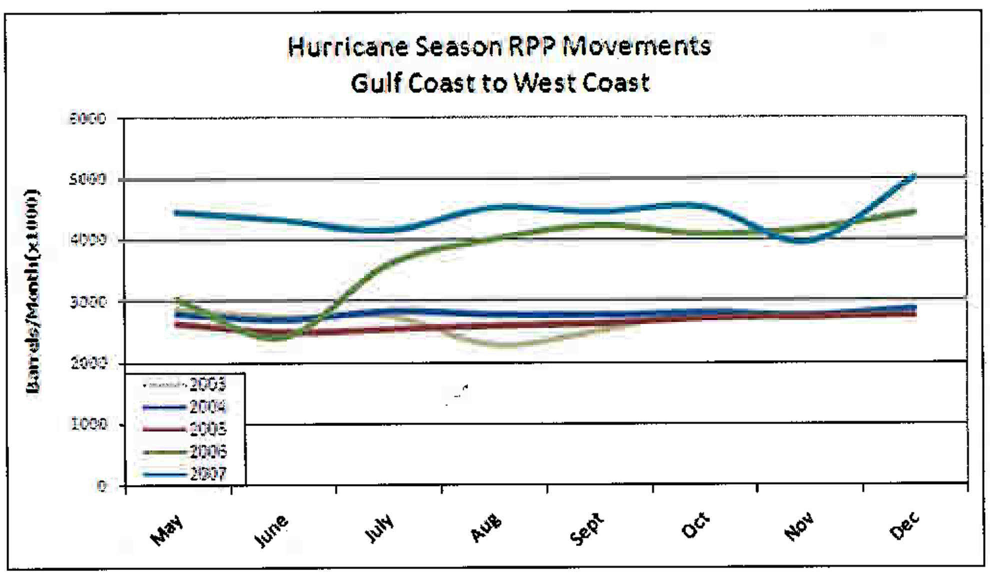

Figure 29: Hurricane season RPP movements from the Gulf Coast to the West Coast, 2003-2007.[36]

[36] Ibid.

SCENARIO 6: HURRICANE SEASON RPP MOVEMENTS FROM THE ROCKY MOUNTAINS TO THE WEST COAST (PADD 4 to 5)

As seen in Figure 30, there was an upward swing of product deliveries from the Rocky Mountains to the West Coast, corresponding with the 2005 hurricane season.

That upswing was in stark contrast to the 2004 August-October timeframe, when exports were stable, at approximately 950,000 bbl/m.

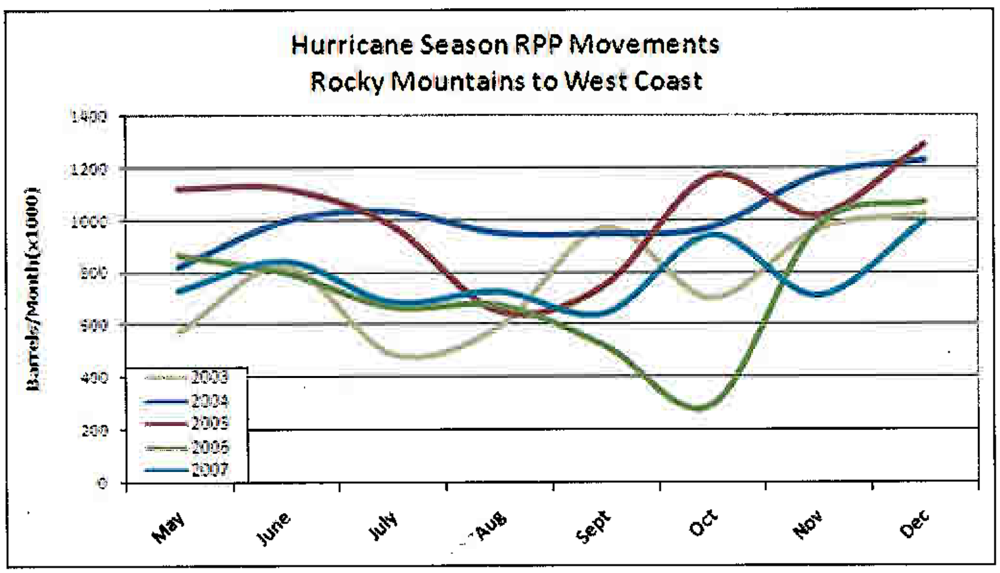

Figure 30: Hurricane season RPP movements from the Rocky Mountains to the West Coast, 2003-2007.[37]

Further our analysis revealed that for the years 2002-2007, the Rocky Mountains region supplied the West Coast with an average of more than one million bbl/m of RPPs. In 2006/2007, that number averaged 760 bbl/m.

We conclude that the Rocky Mountains pipeline system is capable of moving at least one million bbl/m to the West Coast, some 33% more than it did in 2006/2007.

[37] Ibid.

SCENARIO 7: HURRICANE SEASON OIL MOVEMENTS FROM THE ROCKY MOUNTAINS TO THE MIDWEST (PADD 4 to 2)

Like the Gulf Coast, the Midwest is a net importer of oil by pipeline from the Rocky Mountains. In 2003 and 2004, oil flows from the Rocky Mountains to the Midwest varied between 1.1 million bbl/ to 1.9 million bbl/ (Figure 31).

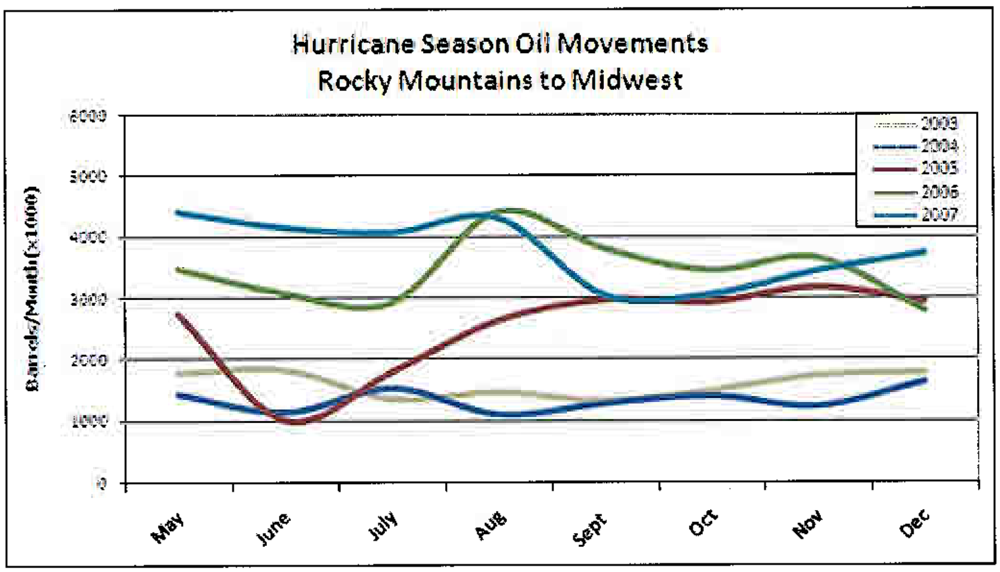

Figure 31: Hurricane season oil movements from the Rocky Mountains to the Midwest, 2003-2007.[38]

Figure 31 shows a dramatic increase in flows—up to some three million bbl/m—during the 2005 hurricane season. It is also apparent that Midwest imports from the Rocky Mountains are increasing. There are three possible explanations for this increase:

- Midwest refineries are relying less on Gulf Coast oil imports, preferring to diversify their supply-streams.
- The price differential of Rocky Mountains oil may be more pronounced, making possible higher profit margins from Rocky Mountains-sourced supply.

[38] Ibid.

- Katrina may have exposed a lack of pipeline capacity from the Rocky Mountains to the Midwest. The asset gap closed soon thereafter, enabling Midwest refiners to ramp up imports from the Rocky Mountains.

SCENARIO 8: HURRICANE SEASON RPP MOVEMENTS FROM THE EAST COAST TO THE MIDWEST (PADD 1 to 2)

Figure 32 exposes two trends: that East Coast exports to the Midwest are relatively stable year round, and that, over time, the Midwest has consistently increased its imports from the East Coast.

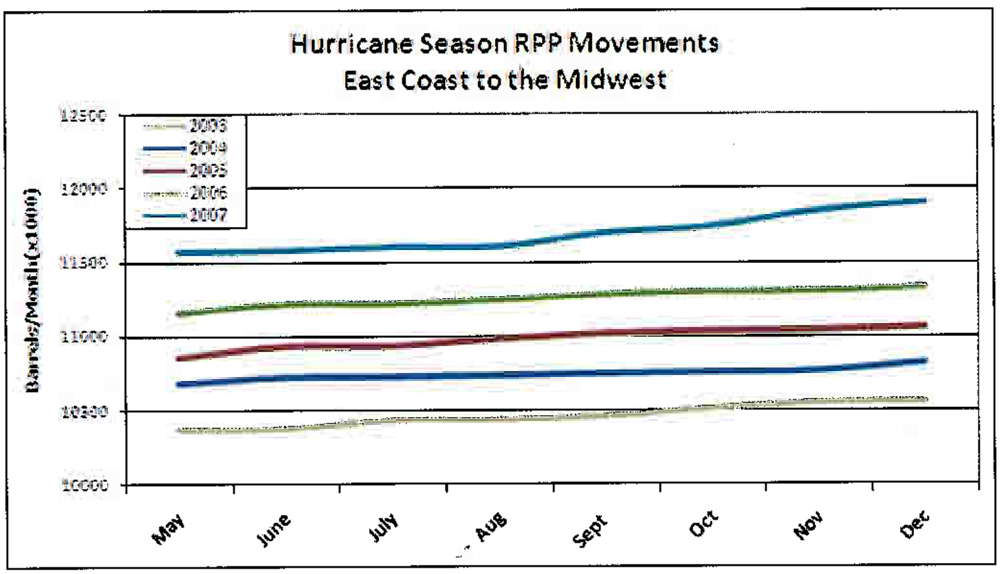

Figure 32: Hurricane season RPP movements from the East Coast to the Midwest, 2003-2007.[39]

In 2007 the Midwest imported 1.2 million bbl/ more than it did in 2003. Thus, we can conclude that the East Coast RPP pipeline network, primarily originating in New York and Pennsylvania, has accommodated an approximate 20% increase in utilization.

[39] Ibid.

SECTION-AT-A-GLANCE

- Significant new pipeline capacity to serve U.S. markets is slated for construction, with most new oil pipelines originating in Canada.
- Pipeline growth is the result of new supplies coming online and the deployment of new technologies used to extract from existing production areas.
- Domestic companies are expanding storage facilities, upgrading existing pipelines and planning new ones to service U.S. production and refining regions.

ANTICIPATING STRONG DEMAND GROWTH

In the next decade, the United States can expect to see many new pipelines initiating service. Most of these pipelines will carry Canadian oil into the U.S. The Canadian Association of Petroleum Producers (CAPP) says that western Canada's total oil supply could increase from 2.5 million bbl/d in 2007 to 3.4 million bbl/d in 2011. This represents an average year-over-year growth rate of almost 230,000 bbl/d during the period.

In projecting growth out to 2020, CAPP analyzed two production and supply cases for oil exports to the United States. In the more bullish, high-growth case, western Canadian oil supply is projected to increase from 2.4 million bbl/d in 2006 to almost 5.3 million bbl/d in 2020. In a moderate growth scenario, CAPP projects supply rising to 4.6 million bbl/d over the same period.

CAPP surveyed Canadian and U.S. refiners to anticipate oil demand growth. They found that demand for western Canadian crude is expected to rise almost 44%, from 765,000 bbl/d in 2006 to 1.1 million bbl/d in 2015. The majority of this demand will be for heavy crude and light synthetic oil. For the same period CAPP found that U.S. refining demand for western Canadian crude will increase by almost 100%, from 1.6 million bbl/d to 3.1 million bbl/d.

Based on these projections, western Canada's pipeline system will need an additional 1 million bbl/d of capacity by 2011, in order to keep pace with demand. Close to 1.3 million bbl/d of new export pipeline capacity is currently slated for completion by 2010, and close to 4 million bbl/d of additional new pipeline capacity is planned for 2011-2020.

New Capacity Coming Online

Figure 33 shows proposed pipeline capacity additions and enhancements in the United States for the 2007-2010 timeframe.

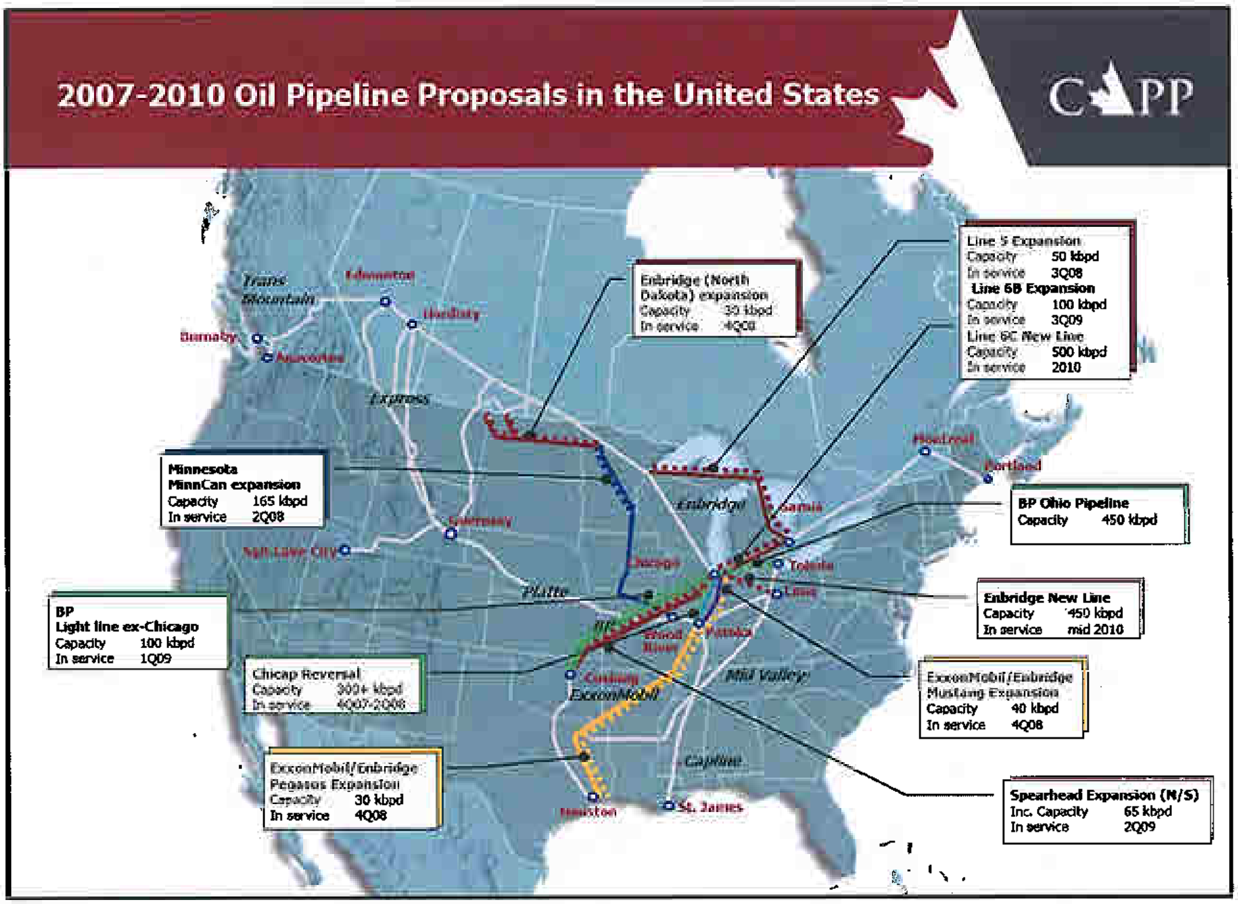

Figure 33: 2007-2010 oil pipeline proposals in the United States.[40]

In addition to the proposed pipelines shown in Figure 33, TEPPCO proposed the Maple New Leaf pipeline from Cushing, Oklahoma to Houston, Texas and an Exxon Mobil/Enbridge partnership announced the Clydesdale New Line. Both these projects are expected to initiate service in 2010 and their combined capacity will be almost 800 bbl/d.

[40] Canadian Association of Petroleum Producers, "Crude Oil Forecast, Markets and Pipeline Expansions" (June 2007).

Figure 34 shows extensive proposed pipeline capacity additions to originate in western Canada for the post-2011 timeframe.

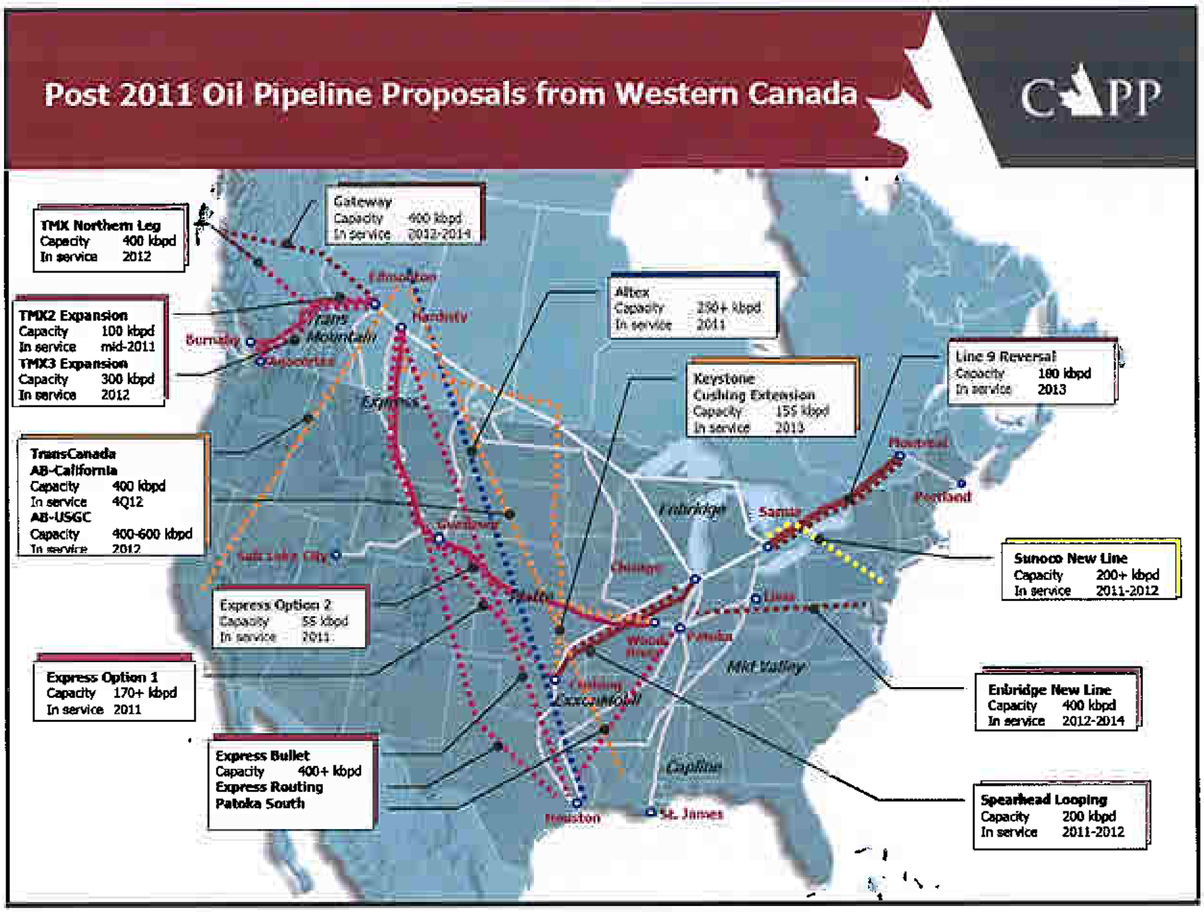

Figure 34: Post-2011 oil pipeline proposals from western Canada.[41]

The pipeline additions and enhancements in Figure 34 comprise approximately 3.7 million bbl/d in new capacity.

Other recently completed or proposed pipeline and storage projects

As shown in the following list, prospective pipeline and storage projects bode well for overall domestic capacity:

- Kinder Morgan Energy Partners recently completed several expansion projects in terminal facilities at the Houston Ship Channel, Texas; New York Harbor, New York; Argo, Illinois; Newport News, Virginia; and Columbus, Mississippi. These expansions increased Kinder Morgan's total liquids storage capacity in its terminals business segment to 51.5 million barrels from 47.5 million barrels.

[41] Ibid.

- The Galena Park Terminal in Houston recently added approximately 650,000 barrels of storage capacity, as five new tanks came online. These tanks were part of a $195 million expansion. Three more tanks are expected to go into service in 2008. This will bring total capacity of the complex to approximately 25 million barrels.

- Construction was completed on nine new liquid storage tanks at the Perth Amboy Terminal in New York Harbor. This project increased capacity for RPPs and chemicals by 1.4 million barrels to approximately 3.7 million barrels. Continued strong demand for products in the Northeast, much of which is being met by imported fuel arriving via New York Harbor, was the catalyst for this $68 million expansion.

- Chaparral Pipeline Company LLC is seeking shipper support for proposed expansion of its 845-mile natural gas liquids pipeline originating in the Permian Basin of West Texas and eastern New Mexico. This expansion project is designed to increase annual average system capacity by nearly 15,000-20,000 bbl/d. It would involve upgrading certain pipeline sections and may include installing additional pumping capability at existing pump stations.

- The Bengal Pipeline Company LLC announced an open season for oil shippers to commit support for a proposed 55,000 bbl/d expansion. Bengal's 24-inch pipeline will connect refineries in Norco, Louisiana to the Plantation Pipeline, and to Bengal's storage tanks in Baton Rouge, Louisiana. Projected completion date is the fourth quarter of 2009.

- Colonial Pipeline Co. announced plans to build a 460-mile pipeline from Jackson, Louisiana to Austell, Georgia. The line will enter Alabama through Sumter County and travel northeast near Interstate 20. The new line would increase capacity by 34 million gallons a day, and Colonial hopes to finish the permitting process by March 2009.

- Rocky Mountain Pipeline System LLC is proposing new and expanded pipeline routes in Wyoming, Colorado and Oklahoma.

Pipeline companies continually seek to improve the value of their assets. In addition to new pipeline construction and upgrading of storage facilities, operators routinely evaluate things like pump station horsepower levels, pipeline alignments and pipeline flow rates in order to maximize their existing operations. And integrated energy companies that own both crude and natural gas pipelines sometimes convert natural gas pipeline service to oil service when gas supplies diminish.

CONCLUSION AND PATH FORWARD

Our study reflects a general consensus that America's energy pipeline transportation system works well. Pipelines provide a safe and inexpensive way to move the liquid energy products we use to heat and cool our homes, fuel our transportation systems, power our electrical generating plants and provide for our national defense. Every day, they transport more than 38 million barrels of oil and RPPs. In addition, pipelines are significantly energy- and labor-efficient; they require the least amount of energy among all transport modes, and, because they are centrally-operated, require the least human intervention.

Turning again to the 2006 PIPES Act:

> *The Secretaries of Transportation and Energy shall conduct periodic analyses of the domestic transport of petroleum products by pipeline. Such analyses should identify areas of the United States where unplanned loss of individual pipeline facilities may cause shortages of petroleum products or price disruptions and where shortages of pipeline capacity and reliability concerns may have or are anticipated to contribute to shortages of petroleum products or price disruptions. Upon identifying such areas, the Secretaries may determine if the current level of regulation is sufficient to minimize the potential for unplanned losses of pipeline capacity.*[42]

We conclude that an analysis sufficient to address Congress' directives would require a dynamic model integrating variables to carry out studies of hypothesized disruptions. There are indications that such models exist in the private sector, but getting appropriate data would be very challenging—perhaps leading to legal antitrust issues—and would require both security clearances and non-disclosure agreements with companies supplying information. Furthermore, it is our opinion that separate models would be needed for the respective oil and RPP pipeline networks.

Unlike natural gas infrastructure modeling, we believe it would be very difficult, if not impossible, to obtain solid results from an RPP network model, because gasoline products consumed in different markets are not fungible. Furthermore, a robust model requires interconnected elements, and oil and RPP pipelines are independent of one another.

There are additional challenges associated with development of a hydraulic model for oil and RPP pipelines. For example, refineries are configured to process specific types of oil, and specific pipelines carry that oil to refineries. If another type of oil with different characteristics is conveyed to a refinery, the refinery will not operate optimally until it is reengineered for the new consignments. RPP pipelines would experience similar problems under similar circumstances.

Yet to be developed is an analysis of where unplanned loss of individual pipelines may cause shortages of products or price disruptions. This analysis, if undertaken, will require cooperation with the Departments of Defense, Energy and Homeland Security, as well as with the petroleum industry on an unprecedented scale.

Some of the factors integrated into such an analysis would include:

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[42] *Pipeline Inspection, Protection, Enforcement and Safety Act of 2006*, Public Law 109-468-Dec. 29, 2006, http://ops.dot.gov/library/docs/pipes_act_of_2006.pdf.

- location and discharge volume at key supply points
- storage tank capacity at or near key supply points
- diversity of supply (e.g., number of feeder lines and their capacity) at each point
- time required for major repairs on ruptured lines supplying key supply points
- time required for mobilizing alternative transport (e.g., trucks, rail, barges) while incident investigations and pipeline repairs are underway

With respect to judging the adequacy of the current level of safety regulation, DOT has already embarked on a comprehensive safety program to put resources where they will do the most good. To support its core safety mission, DOT carries out an extensive safety program. This program includes:

- promulgation of regulations
- inspection and enforcement activities to ensure compliance with regulations
- development and demonstration of new and emerging technologies to improve safety performance
- stakeholder outreach programs that help resolve issues beyond the scope of regulation

Regulations serving as the foundation of these programs have been expanded during the past few years to include integrity management and operator qualification components. These require operators to implement management systems that support:

- an understanding of the spectrum of threats to pipeline integrity
- evaluating risks associated with these threats
- assessing physical integrity of pipelines whose failure could affect high consequence areas
- mitigating any physical defects discovered
- assuring the qualification of individuals performing work on pipeline systems

These systems-focused regulations, while not comprehensive in dealing with every aspect of management systems, have significantly strengthened DOT's ability to prevent pipeline failures.

Under its systems-focused regime, DOT uses better analysis and a more complete understanding of risk, in planning for and conducting inspections. Risks are classified into distinct categories such as design, engineering and technical risk; operational risk based on material performance; reliability and serviceability risk; and risk associated with organizational safety culture.

Also under these systems-focused methods, inspections are more "customized" than in the past, and performance of individual operators has significant bearing on how they are inspected. DOT exercises greater flexibility in determining which areas of operations are inspected and at what depth; which field locations are inspected, and how often; and whether (and how often) follow-up inspections are conducted.

Although much progress has been made, additional analyses and program enhancements will improve DOT's ability to carry out its mission.

DOT fully supports the intent of Congress as expressed in the PIPES Act. The current study has enabled us to better understand the implications and challenges involved in fulfilling those aims, and we look forward to collaborating with the Departments of Energy and Homeland Security in doing so.

APPENDIX 1

SUPPLEMENT TO CASE STUDY THREE: AN EXAMINATION OF HURRICANE SEASON GASOLINE STOCKS, 2003-2007

RPP stocks fulfill a critical function in energy commodity supply chains.

We have seen that RPP storage terminals are scattered throughout the United States. States with large consumption swings tend to have more storage than others. Storage terminals help states and surrounding regions temporarily weather supply disruptions, by providing tanker trucks and railroad tankers with access to supplies (where rail spurs exist). Storage terminals can also be tapped to augment pipeline supplies, when downstream of a failure.

Having considered the strategic significance of storage terminals, and their importance to the pipeline network, DOT analyzed gasoline stocks in selected clusters of states. DOT elected to focus only on states in the Gulf Coast and the East Coast where demand is relatively high, and where impressions of supply constraints exist.

Figure A-1 shows stocks in three state clusters from January 2003 through December 2007. We also highlight stocks in these three clusters during the Katrina/Rita timeframe.

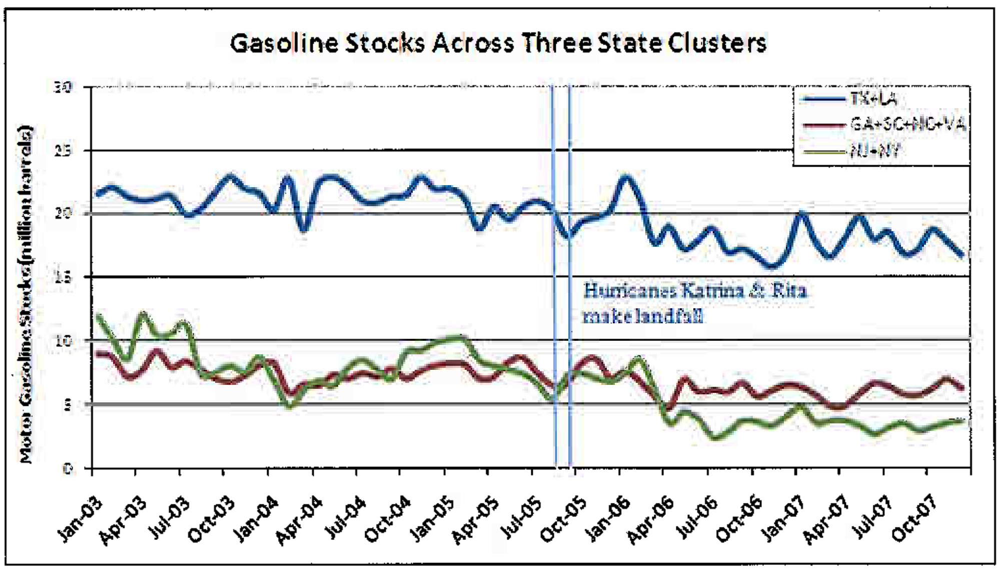

Figure A-1: Gasoline stocks across three state clusters, 2003-2007.[43]

As key refining centers with deepwater ports, Texas and Louisiana have the largest stocks. The Northeast and Mid-Atlantic clusters have much smaller stocks than the Gulf Coast states.

[43] (J. Kadnar, unpublished data)

Other important information is illustrated in Figure A-1. Stocks are falling in all clusters. Before July 2005, New York and New Jersey had larger stocks than the Mid-Atlantic states; now their stocks have diminished, and since April 2006 has consistently been lower than those in the Mid-Atlantic states.

When regions have fewer RPP stocks in storage, they are more susceptible to price spikes due to pipeline or maritime disruptions. RPPs, being finished products, are expensive to hold onto. Because gasoline marketers and terminal operators deal in a finished product, they are inclined to hold—under normative market conditions—relatively small stocks, as opposed to building up large holdings.

Figure A-2 demonstrates percentage changes in stocks from 2003-2007, among the same three state clusters.

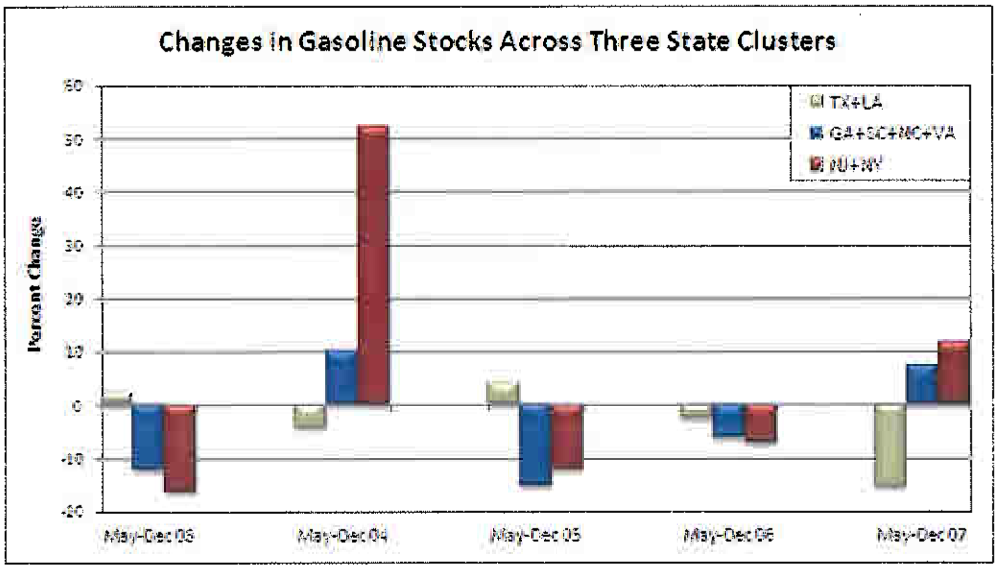

Figure A-2: Changes in gasoline stocks across three state clusters, 2003-2007.[44]

Most revealing is the fact that Gulf Coast stocks are stable, with the highest and lowest variation being just 1/10th of 1%. This is a number that inspires confidence, because it shows that where major pipelines can operate, then disruptions to downstream markets can be contained, even when refineries are disabled.

There are few conclusions that can be drawn from the stocks data in the other clusters. However, it does appear that the Northeast and Mid-Atlantic clusters see positive stock changes before the summer driving season and prior to the hurricane season.

One would have expected dramatic RPP storage draw-downs during the 2005 hurricane season. We don't see evidence of this in Figure A-2, however. Unlike the two preceding and two succeeding years, Gulf Coast stocks were surprisingly positive at the end of the Katrina/Rita timeframe.

It is tempting to conclude that gasoline stocks were confined to Texas and Louisiana due to hurricane-induced pipeline disruptions, but this does not appear to be the case. As we show in the next section, the Colonial and Plantation pipelines resumed full utilization within a week after they lost power.

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[44] Ibid.

Another anomalous finding from this figure is the negative trend in Gulf Coast stocks in 2006 and 2007. We have shown previously that the Midwest and the East Coast have become less dependent on refined products from the Gulf Coast. However, Gulf Coast stocks in 2006 and 2007 have trended downward. This may be occurring because terminal operators have learned to better manage their stocks.

The Northeast and Mid-Atlantic clusters experienced positive changes at the end of the hurricane season twice in the past five years (2004 and 2007). This is encouraging, even against the backdrop of a general downward trend in stocks.

POST-KATRINA RPP PIPELINE SERVICE RESUMPTION TO THE EAST COAST

We have examined how Colonial Pipeline Company and Plantation Pipeline Company responded to power outages, and ramped up their utilization rates after regaining power in the wake of Hurricane Katrina.

Plantation operates one pipeline, which originates on the Gulf Coast and terminates in Virginia. Colonial operates two pipelines originating on the Gulf coast and terminating in New York.

During the hurricane, Colonial and Plantation lost power to a series of pump stations. Pump stations are the prime movers of commodities in pipelines. Depending on a pipeline's configuration and the nature of the terrain that it covers, a pipeline can usually operate after losing one or two pumping stations. It is impossible to continue operating after the loss of three pump stations in a series, however, as happened in these cases.

The pump stations lost power on August 29th. The federal government and the private sector began restoring their power the next day. Plantation acquired full commercial power on September 1st; Colonial secured full commercial power on September 5th. Figure A-3 illustrates the utilization curve as the pipelines were repowered and operations restored.

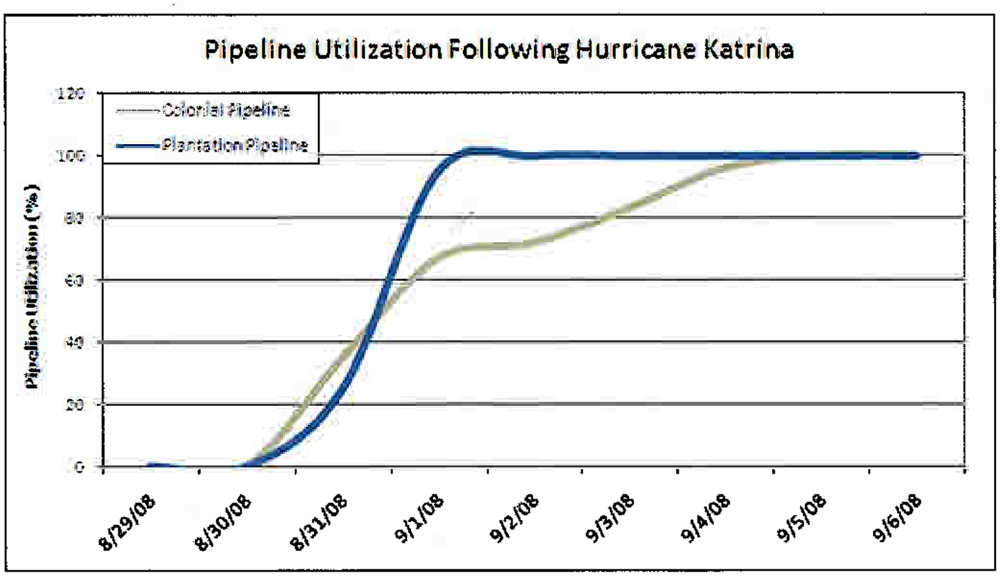

Figure A-3: Pipeline utilization following Hurricane Katrina.[45]

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[45] Ibid.

Figure A-4 shows Colonial and Plantation throughputs as power at the pump stations was gradually restored.

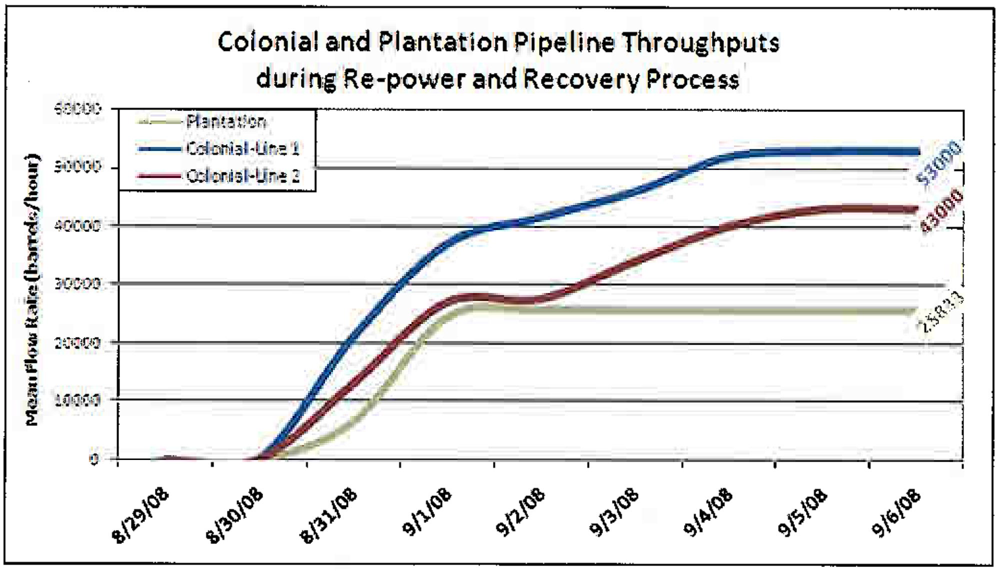

Figure A-4: Colonial and Plantation pipeline throughputs during re-power and recovery process.[46]

As power was restored, the pipelines' throughputs increased. On September 1st, three days after Katrina made landfall, Plantation was transporting its full complement of almost 26,000 barrels/hour (bph). Colonial secured full power on September 5th, when its Line 1 was transporting 53,000 bph and its Line 2 was transporting 43,000 bph.

[46] Ibid.

APPENDIX 2

PIPELINE INSPECTION, PROTECTION, ENFORCEMENT, AND SAFETY ACT OF 2006

120 STAT. 3486 PUBLIC LAW 109–468—DEC. 29, 2006

SEC. 8. PETROLEUM TRANSPORTATION CAPACITY AND REGULATORY ADEQUACY STUDY.

(a) IN GENERAL.—Chapter 601 (as amended by sections 2(b) and 6 of this Act) is further amended by adding at the end the following:

"§ 60136. Petroleum product transportation capacity study

"(a) IN GENERAL.—The Secretaries of Transportation and Energy shall conduct periodic analyses of the domestic transport of petroleum products by pipeline. Such analyses should identify areas of the United States where unplanned loss of individual pipeline facilities may cause shortages of petroleum products or price disruptions and where shortages of pipeline capacity and reliability concerns may have or are anticipated to contribute to shortages of petroleum products or price disruptions. Upon identifying such areas, the Secretaries may determine if the current level of regulation is sufficient to minimize the potential for unplanned losses of pipeline capacity.

"(b) CONSULTATION.—In preparing any analysis under this section, the Secretaries may consult with the heads of other government agencies and public- and private-sector experts in pipeline and other forms of petroleum product transportation, energy consumption, pipeline capacity, population, and economic development.

"(c) REPORT TO CONGRESS.—Not later than June 1, 2008, the Secretaries shall submit to the Committee on Energy and Commerce and the Committee on Transportation and Infrastructure of the House of Representatives and the Committee on Commerce, Science, and Transportation and the Committee on Energy and Natural Resources of the Senate a report setting forth their recommendations to reduce the likelihood of the shortages and price disruptions referred to in subsection (a).

"(d) ADDITIONAL REPORTS.—The Secretaries shall submit additional reports to the congressional committees referred to in subsection (c) containing the results of any subsequent analyses performed under subsection (a) and any additional recommendations, as appropriate.

"(e) PETROLEUM PRODUCT DEFINED.—In this section, the term 'petroleum product' means oil of any kind or in any form, gasoline, diesel fuel, aviation fuel, fuel oil, kerosene, any product obtained from refining or processing of crude oil, liquefied petroleum gases, natural gas liquids, petrochemical feedstocks, condensate, waste or refuse mixtures containing any of such oil products, and any other liquid hydrocarbon compounds.".

(b) CLERICAL AMENDMENT.—The analysis for chapter 601 (as amended by sections 2(b) and 6 of this Act) is further amended by adding at the end the following:

"60136. Petroleum product transportation capacity study.".

Glossary

barrel. A barrel is a standard measure of a volume of oil and is equal to 42 gallons.

bbl/d. An abbreviation for barrels per day.

bbl/m. An abbreviation for barrels per month.

crude oil (oil). Crude oil is oil that is extracted from the ground before it is refined into usable products, such as gasoline. Technically speaking, crude oil is the raw liquid petroleum product extracted from oil wells. It is a mixture of thousands of chemicals and compounds, primarily hydrocarbons. Crude oil must be broken down in its various components by distillation before these chemicals and compounds can be used as fuels or converted to more valuable products. Crude oil is classified as either 'sweet crude' (sulfur content less than 0.5%) or 'sour crude,' (at least 2.5% sulfur).

feedstocks. The key raw materials of crude oil and refined petroleum products used to create petrochemicals, plastics, solvents and hundreds of other intermediate and end-user goods.

hazardous liquid. A hazardous liquid is a liquid that is dangerous to human health or safety or the environment if used incorrectly or if not properly stored or contained. Pipeline safety regulations identify petroleum, petroleum products, or anhydrous ammonia as hazardous liquids.

hydrostatic pressure testing. A method of testing pipeline integrity in which the line is filled with a liquid, usually water, and then the pressure of the liquid is raised to a specified pressure that is maintained for a specified period of time, Any ruptures or leaks revealed during the test must be repaired and the test repeated until no problems are noted.

inline inspection. A method of inspecting a pipeline using an inline inspection tool or smart pig. (ILI is also known as Internal Inspection or Smart Pigging.) An ILI tool is inserted into a pipeline and, usually, is pushed through the line by the pressure of the fluid being transported. Different ILI techniques and tools are designed to detect defects in the pipe wall and on the internal and external surfaces of the pipe. Defects can include areas of corrosion, dents, metal loss, and the presence of cracks.

LPG. An abbreviation for liquefied petroleum gas. A type of gas containing certain specific hydrocarbons that are gaseous under normal atmospheric conditions, but can be liquefied under moderate pressure at normal temperature. Propane and butane are principal examples.

PADD. An abbreviation for Petroleum Administration for Defense Districts. They are:

- PAD District I (East Coast) is composed of the following three subdistricts:
  - Subdistrict IA (New England): Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont;
  - Subdistrict IB (Central Atlantic): Delaware, District of Columbia, Maryland, New Jersey, New York and Pennsylvania;
  - Subdistrict IC (Lower Atlantic): Florida, Georgia, North Carolina, South Carolina, Virginia and West Virginia.
- PAD District II (Midwest) consists of Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Ohio, Oklahoma, Tennessee and Wisconsin.
- PAD District III (Gulf Coast) comprises Alabama, Arkansas, Louisiana, Mississippi, New Mexico and Texas.

- PAD District IV (Rocky Mountain) includes Colorado, Idaho, Montana, Utah and Wyoming.
- PAD District V (West Coast) consists of Alaska, Arizona, California, Hawaii, Nevada, Oregon and Washington.

PIPES. An abbreviation for the Pipeline Inspection, Protection, Enforcement and Safety Act of 2006.

RPP. An abbreviation for refined petroleum products, such as gasoline, diesel fuel, aviation fuel, fuel oil, kerosene, any product obtained from refining or processing of crude oil, liquefied petroleum gases, natural gas liquids, petrochemical feedstocks, condensate, waste or refuse mixtures containing any such oil products, and any other liquid hydrocarbon compounds.

spot prices. The current price at which a particular commodity can be bought or sold at a specified time and place.

ULSD. An abbreviation for ultra-low sulfur diesel, which is a standard for defining diesel fuel with substantially lowered sulfur contents. As of 2006, almost all of the petroleum-based diesel fuel available in North America is of a ULSD type.

WTI. An abbreviation for West Texas Intermediate. WTI, also known as Texas Light Sweet, is a premium type of crude oil that is used as a benchmark in global oil pricing. It is extracted from a region in West Texas that produces high grade, low sulphur crude.

"(B) subject to the jurisdiction of the Commission under the Natural Gas Act (15 U.S.C. 717 et seq.);"; and

(2) by striking paragraph (9) and inserting the following:

"(9) 'intrastate gas pipeline facility' means a gas pipeline facility and transportation of gas within a State not subject to the jurisdiction of the Commission under the Natural Gas Act (15 U.S.C. 717 et seq.);".

SEC. 8. PETROLEUM TRANSPORTATION CAPACITY AND REGULATORY ADEQUACY STUDY.

(a) IN GENERAL.—Chapter 601 (as amended by sections 2(b) and 6 of this Act) is further amended by adding at the end the following:

"§ 60136. Petroleum product transportation capacity study

"(a) IN GENERAL.—The Secretaries of Transportation and Energy shall conduct periodic analyses of the domestic transport of petroleum products by pipeline. Such analyses should identify areas of the United States where unplanned loss of individual pipeline facilities may cause shortages of petroleum products or price disruptions and where shortages of pipeline capacity and reliability concerns may have or are anticipated to contribute to shortages of petroleum products or price disruptions. Upon identifying such areas, the Secretaries may determine if the current level of regulation is sufficient to minimize the potential for unplanned losses of pipeline capacity.

"(b) CONSULTATION.—In preparing any analysis under this section, the Secretaries may consult with the heads of other government agencies and public- and private-sector experts in pipeline and other forms of petroleum product transportation, energy consumption, pipeline capacity, population, and economic development.

"(c) REPORT TO CONGRESS.—Not later than June 1, 2008, the Secretaries shall submit to the Committee on Energy and Commerce and the Committee on Transportation and Infrastructure of the House of Representatives and the Committee on Commerce, Science, and Transportation and the Committee on Energy and Natural Resources of the Senate a report setting forth their recommendations to reduce the likelihood of the shortages and price disruptions referred to in subsection (a).

"(d) ADDITIONAL REPORTS.—The Secretaries shall submit additional reports to the congressional committees referred to in subsection (c) containing the results of any subsequent analyses performed under subsection (a) and any additional recommendations, as appropriate.

"(e) PETROLEUM PRODUCT DEFINED.—In this section, the term 'petroleum product' means oil of any kind or in any form, gasoline, diesel fuel, aviation fuel, fuel oil, kerosene, any product obtained from refining or processing of crude oil, liquefied petroleum gases, natural gas liquids, petrochemical feedstocks, condensate, waste or refuse mixtures containing any of such oil products, and any other liquid hydrocarbon compounds.".

(b) CLERICAL AMENDMENT.—The analysis for chapter 601 (as amended by sections 2(b) and 6 of this Act) is further amended by adding at the end the following:

"60136. Petroleum product transportation capacity study.".