Prepared for:

University of Alaska Fairbanks
Paul A. Metz
313 Duckering Building PO Box 755800
Fairbanks, AK 99775

Alaska Canada Rail Link Feasibility Study, Phase I:

Analysis of Rail Link Impact on North Slope Development, Current Transportation Risks, and Shared Corridor Synergie

June 2006

(DRAFT Analysis based on design / project assumptions as of June 30th 2006)

Lockheed Martin Space Operati
Anchorage, Ala

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Chapter 1.0: Market Analysis of Supply and Demand to Current and Future North Slope Oil and Gas Activity

1.1 Introduction

1.1.1 Purpose of Chapter

The purpose of this chapter is to provide research and analysis on the following:

- Assess the market for the rail transport of oil and gas field supplies and equipment from the contiguous states and southern Canada to the North Slope of Alaska.
- Assess the market for the rail transport of a materials and equipment in support of the construction and operation and maintenance of the Alaska Natural Gas Pipeline and other North Slope developments.

The results of this work will be meshed with other project team segments of a broader market analysis, all of which are part of the Alaska Canada Rail Link Feasibility Study, Phase I.

The information presented in this chapter is subdivided into the following two sections:

- Present North Slope Supply and Demand: Support by Transportation Mode
- Future North Slope Resource Development

The purpose of this chapter is not to make any broad generalizations or to state the feasibility or unfeasibility of the ACRL. Rather, the objective of this chapter is to provide as much detail on the key issues identified above as possible, in order to educate and inform U.S. and Canadian decision makers.

1.1.2 Research Limitations

Throughout the data collection and analysis processes, researchers faced many challenges. The challenges were as follows:

- Data availability: Some information was not available at a level applicable to this study.
- Dated information: Some of the most recent data available is approaching ten years old.
- Inconsistent data: At different points in history, State agencies have collected different types of data, used different regional breakdowns.
- Non-responsive sources: Some calls to potential sources were not returned, or data was not provided on a timely basis.
- Data is snapshot: Most data is not available for multiple years, providing limited time periods of information.

Figure 1: Current and Proposed Alaska-Canada Development Projects

Before discussing current supply to the North Slope oil patch, ***Figure 1*** provides the reader with a visual of the multiple transportation routes discussed in this chapter, including the Alaska Railroad, the Alaska Highway System, as well as the proposed Alaska Gas and Alaska Canada Rail Link.

1.2 Current North Slope Supply and Demand and Support by Transportation Mode

Section 1.2 details the current North Slope demand for oil field supplies and equipment operations and maintenance. This includes figures for bulk chemicals and tubulars. The information is presented by transportation mode:

- Alaska Railroad
- Alaska Highway System
- Alaska Ports and Multimodal Transportation

Each section includes an overview of current activity (including support to North Slope oil and gas), a more limited discussion of the capacity and potential of each mode, as well as other issues to further explore. To set the stage, ***Figure 2*** depicts North Slope Oil and Gas Activity and Discoveries, as of January 2006.

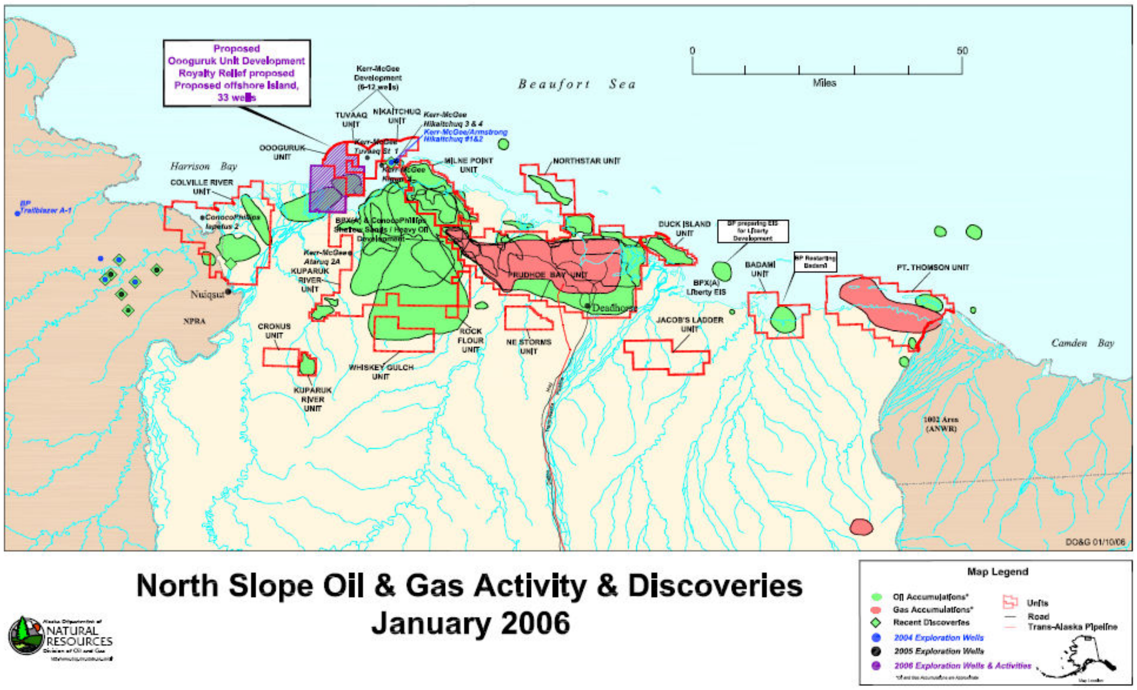


Figure 2: North Slope Oil and Gas Activity and Discoveries, January 2006

To better understand the critical link between the movement of commodities by transportation mode and supply to North Slope oil activity, one must be familiar with both past and current activity. Additionally, through an analysis of well data provided by the Department of Revenue, a model (represented in ***Figure 3*** and ***Figure 4***) helps to better define the total volumes of chemical and tubular shipped to the North Slope.

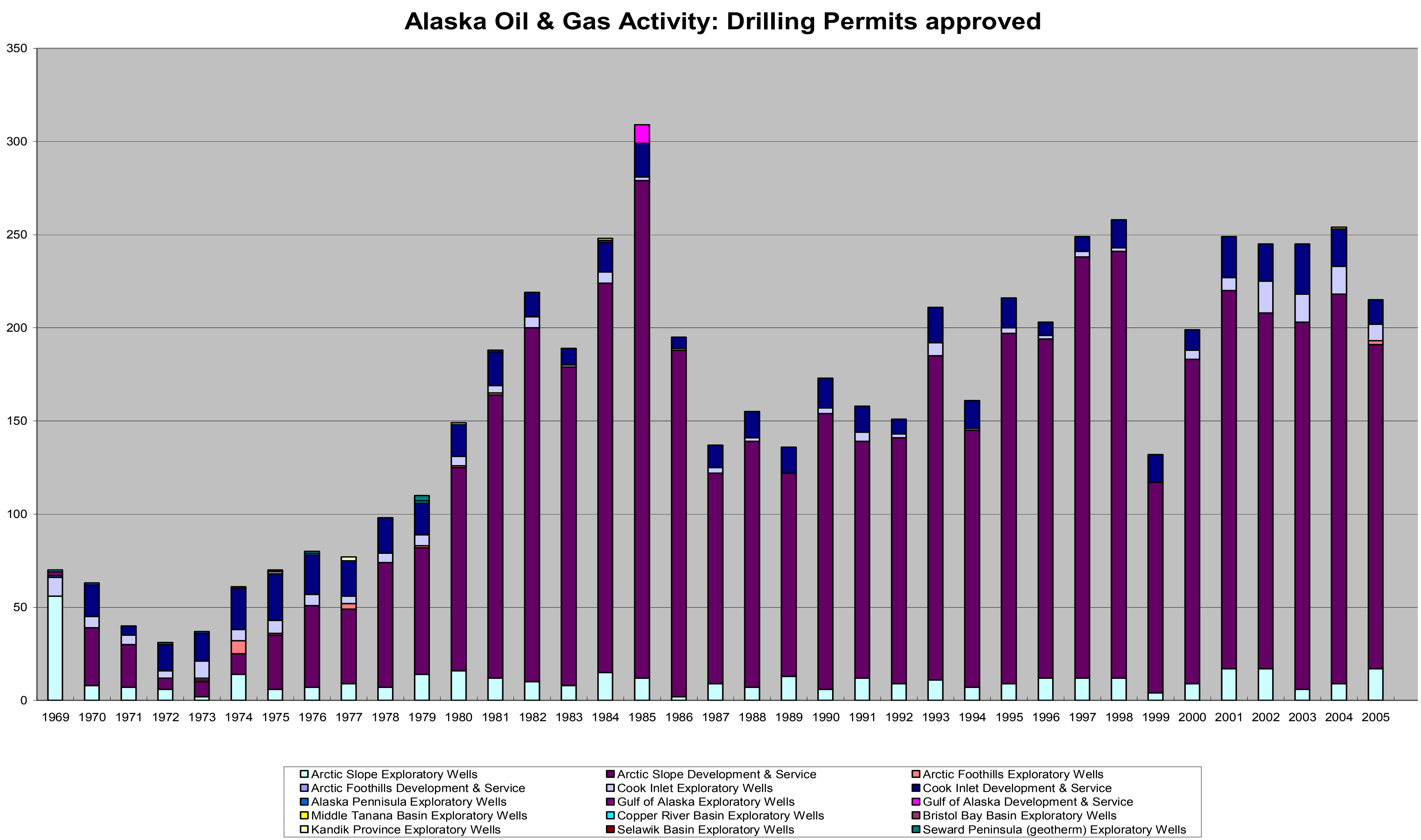


Figure 3: Alaska Oil & Gas Activity, Drilling Permits Approved

As shown in ***Figure 3***, drilling permits are a very direct indication of planned drilling activity. The vast majority of drilling permits are related to development and service drilling activity on the Arctic Slope. As shown here, the number of exploratory drilling permits on the Arctic Slope has nearly doubled in 2005.

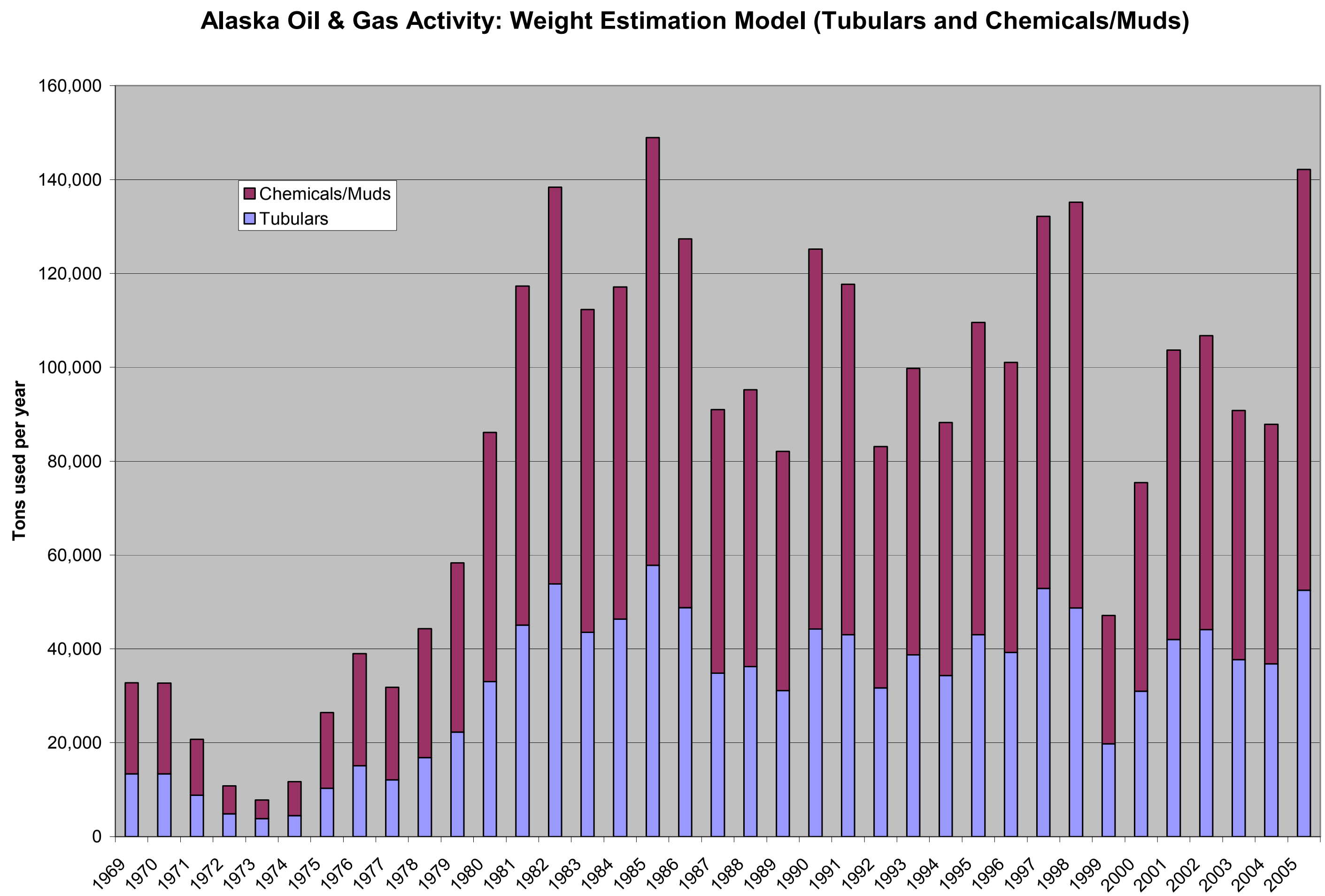


Figure 4: Weight Estimation Model (Tubulars and Chemicals/Muds)

Tubular steel and chemical/drilling muds were identified as two general commodity types that are used in great volumes on the Arctic Slope associated with oil production. This figure provides a glimpse of volumetric demand modeling associated with permitted and completed drilling on the Arctic Slope.

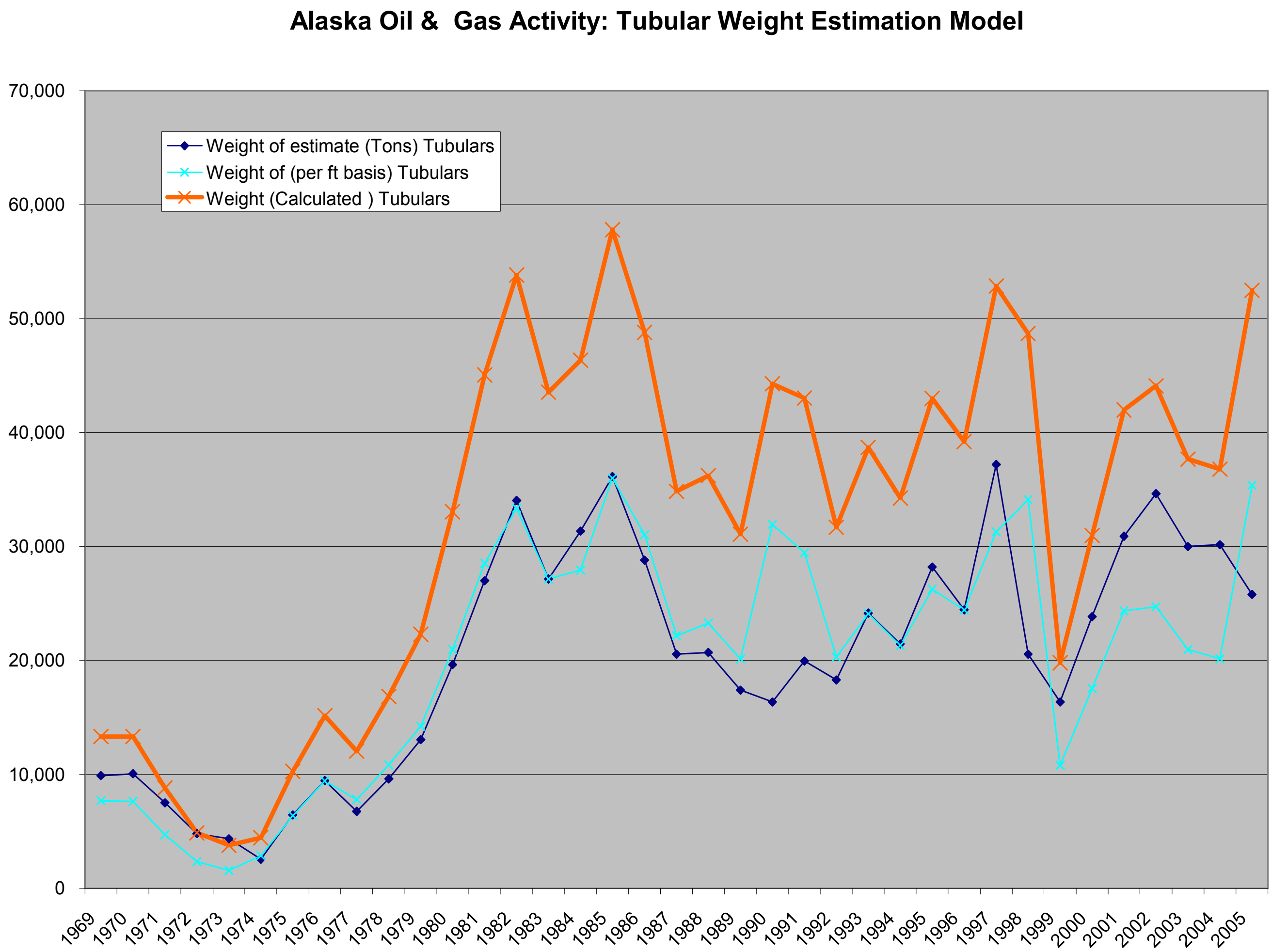


Figure 5: Tubular Weight Estimation Model

Figure 5 shows three different methods for estimating tubular and chemical/mud volumes associated with drilling activity levels. Conoco Phillips staff provided information about tubular volumes transported to the Arctic Slope during the last two years. A drilling operator provided more specific usage volumes attributed to exploration drilling. Information from the Alaska Oil and Gas Conservation Commission and the Alaska Department of Revenue related to drilling activity and oil production were then used to create three models for estimated current and future commodity transportation requirements. The figure depicts the outcomes of the three methods.

The average number of feet drilled per well has increased dramatically in 2005 to 12,000 ft. Previously, average completion depths were generally between 6,000 and 10,000 feet per well. The number of wells drilled had increase substantially since 2000. Part of the explanation for the increased depth of drilling is that newer technology has allowed for multi-lateral entries in existing locations.

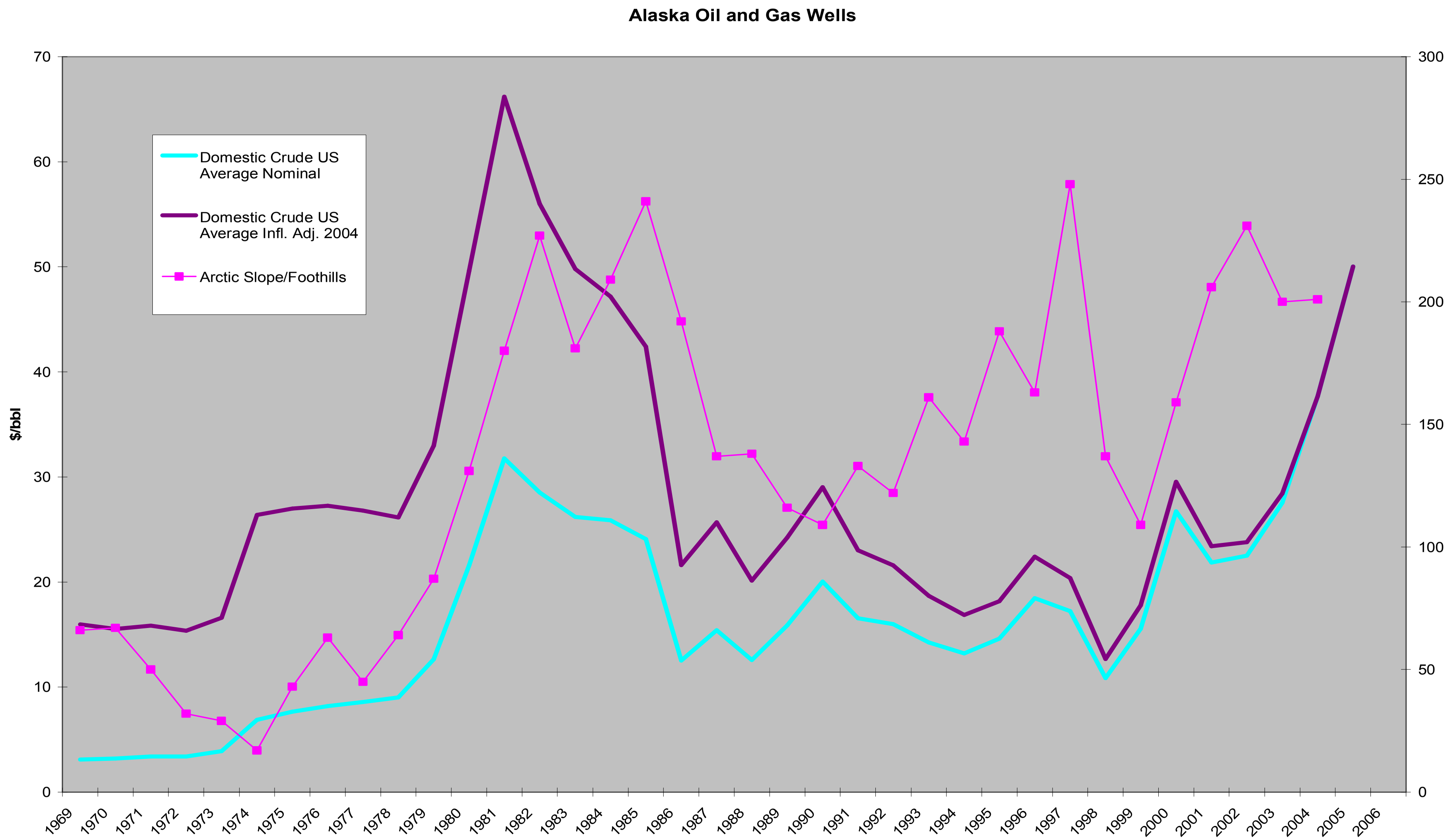


Figure 6: Alaska Oil and Gas Well

Figure 6 and ***Figure 7*** provide a picture of the relationship between feet drilled per year, the number of wells and the price of oil. A close relation is evident between the Inflation Adjusted price of oil and the number of wells drilled on the Arctic Slope. This figure also shows two distinct increases in drilling activity; 1973-82 and 1998-present. Each corresponds with the two (real and nominal) most significant run-ups in oil price during the last 35 years.

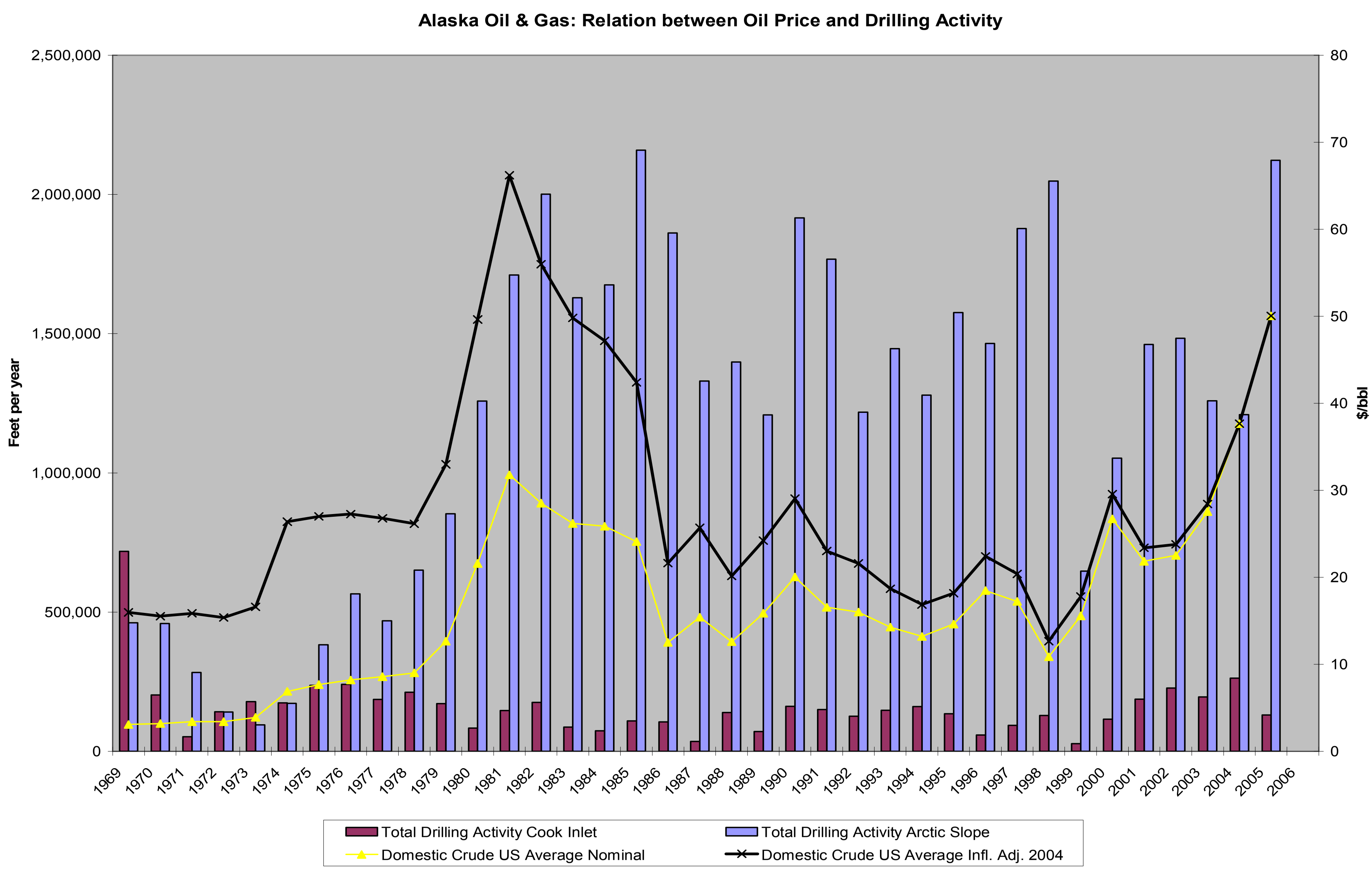


Figure 7: Relation between Oil Price and Drilling Activity

1.2.1 Alaska Railroad

According to current Alaska Railroad Corporation Director of Strategic Planning, Bruce Carr, 80% of freight transported by the Alaska Railroad (ARR) moves in a southerly direction, from Fairbanks to Anchorage. That 80% is comprised of gas and jet fuel (40%), gravel (30%), and coal (10%). The other approximately 20% of freight that moves by rail comes in from Whittier and Seward and does not go further north than Anchorage.

In terms of providing for surrounding communities, the ARR offers very little community support in the form of products. There are some bulk loads for large materials (e.g. lumber), but most community support traffic moves via ground freight. Railroads are designed more for rolling inventories, as they cannot be relied upon for last minute support (as is often required for consistent and timely delivery of community supplies). Additionally, the minimum load on a railroad is 50,000-60,000 pounds, which is usually surpasses the poundage transported by community support companies.

Figure 8 gives an overview of each commodity group moved via rail to Alaskan locations in 2005. The top five commodities transported via rail to Alaska in 2005 were as follows:

- Primary Metal Products (38,187 tons)
- Chemical or Allied Products (36,599 tons)
- Lumber or Wood (15,426 tons)
- Petroleum or Coal Products (13,445 tons)
- Non-Metallic Minerals (6,694 tons)

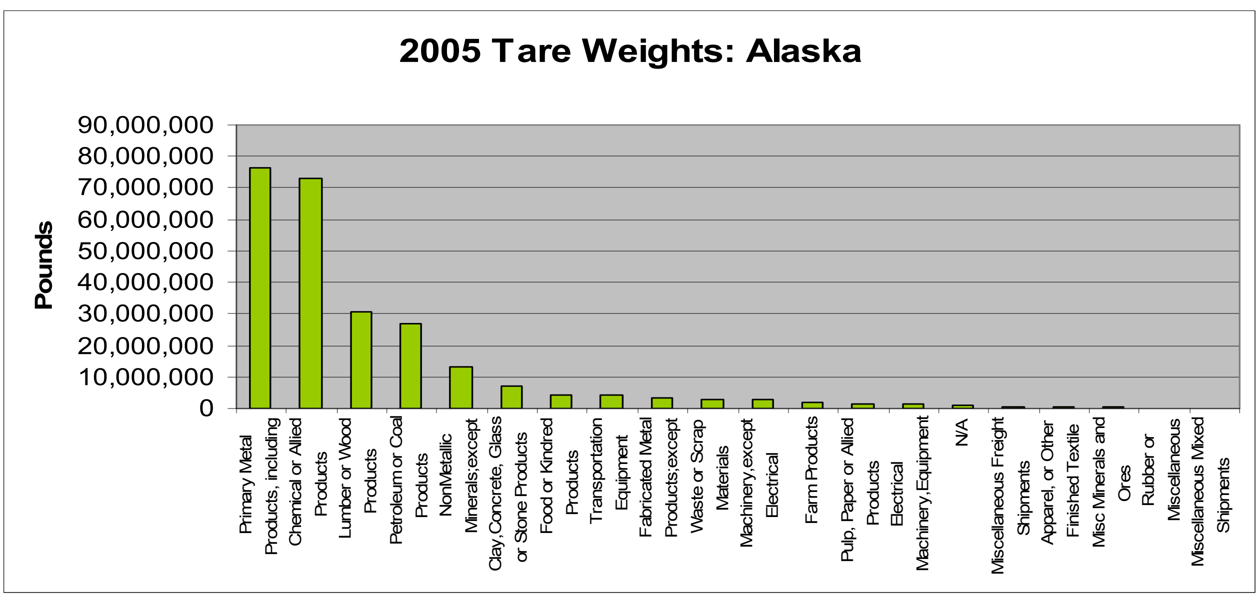


Figure 8: 2005 Tare Weights, Alaska Statewide

Figure 9 reveals what percentages of commodities shipped to Anchorage (33%), Fairbanks (56%) and other Alaska locations (11%).

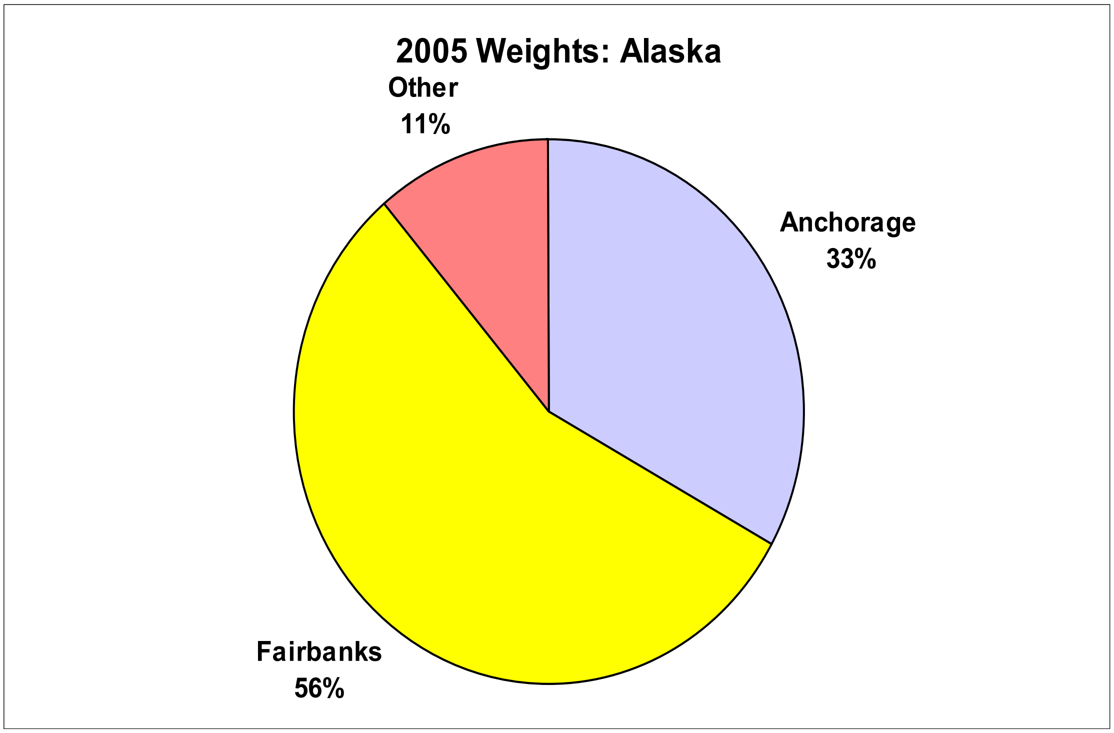


Figure 9: 2005 Tare Weight Percentages by Region

Figure 10, ***Figure 11***, and ***Figure 12*** further detail rail commodities shipped to Anchorage, Fairbanks and other Alaska locations. Below each figure is a bulleted list of the top five commodities and related tonnages. Chemicals (includes chemical/allied products and clay/concrete/glass stone products) and tubular (includes primary metals and fabricated metals) comprise the top 5 or 6 commodities moving via rail to Alaskan communities.

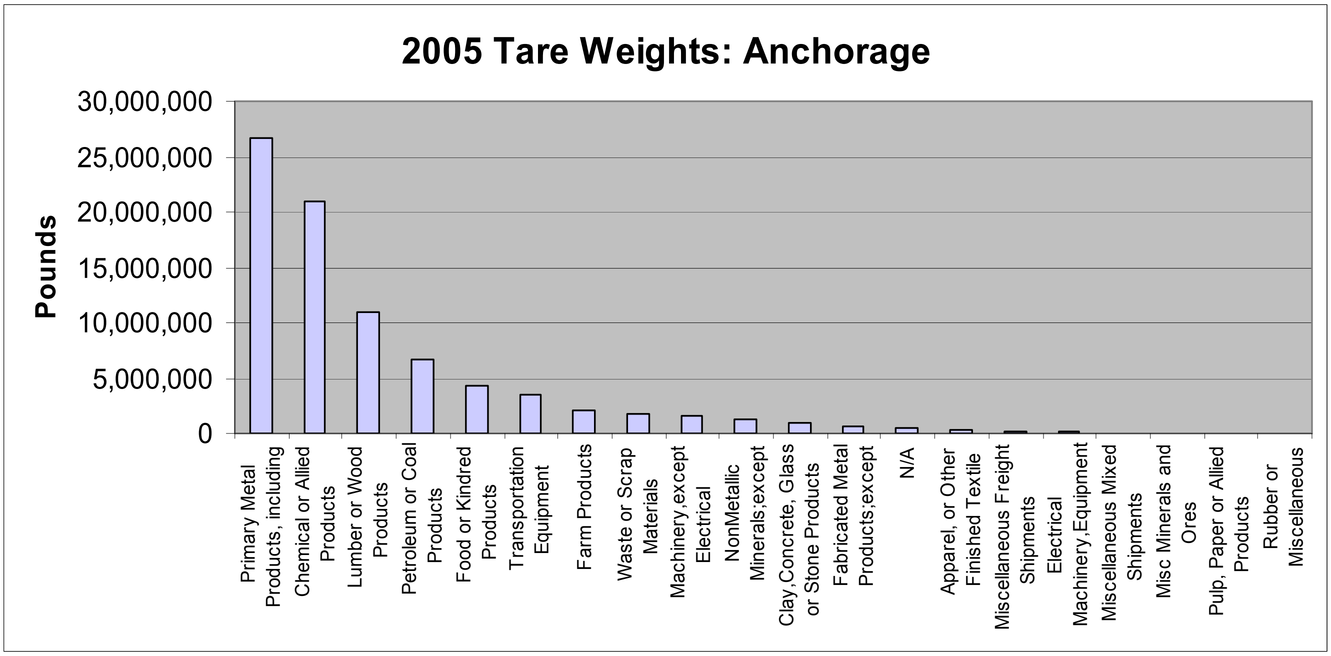


Figure 10: 2005 Tare Weights, Anchorage

- Primary Metals (13,337 tons)
- Chemicals or Allied Products (10,447 tons)
- Lumber or Wood (5,512 tons)
- Petroleum or Coal Products (597 tons)
- Food or Kindred Products (2,177 tons)

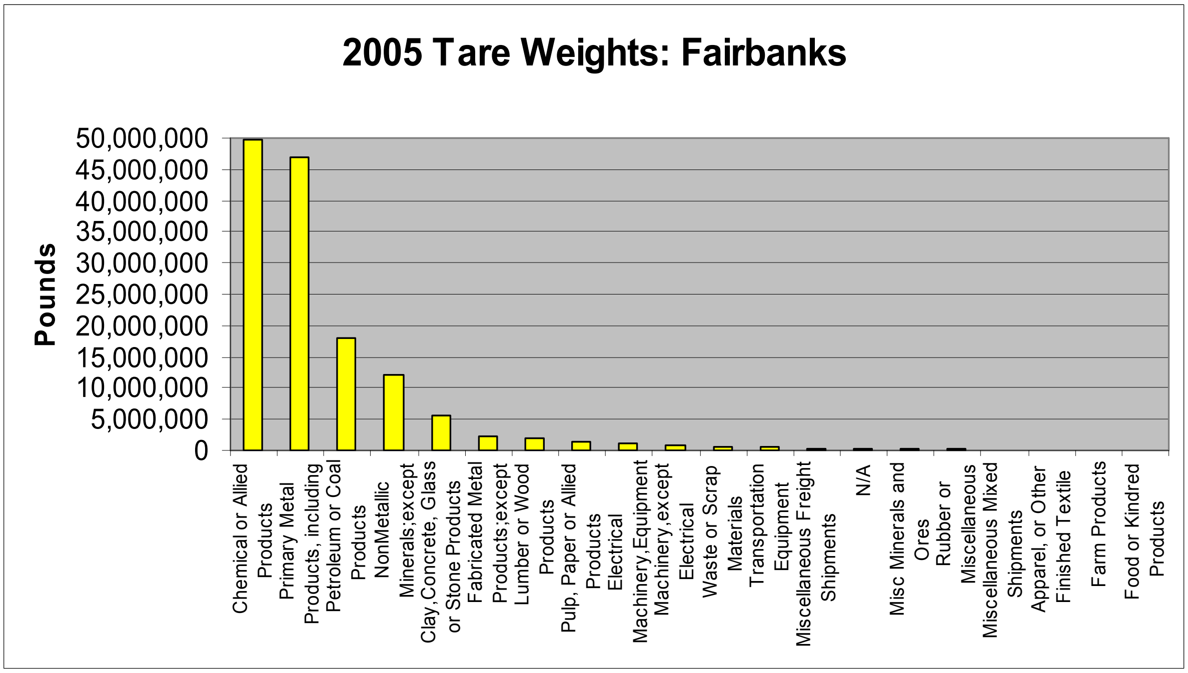


Figure 11: 2005 Tare Weights, Fairbanks

- Chemicals or Allied Products (24,794 tons)
- Primary Metals (23,474 tons)
- Petroleum or Coal Products (9,036 tons)
- Non-Metallic Minerals (6,041 tons)
- Clay, Concrete, Glass or Stone Products (2,785 tons)

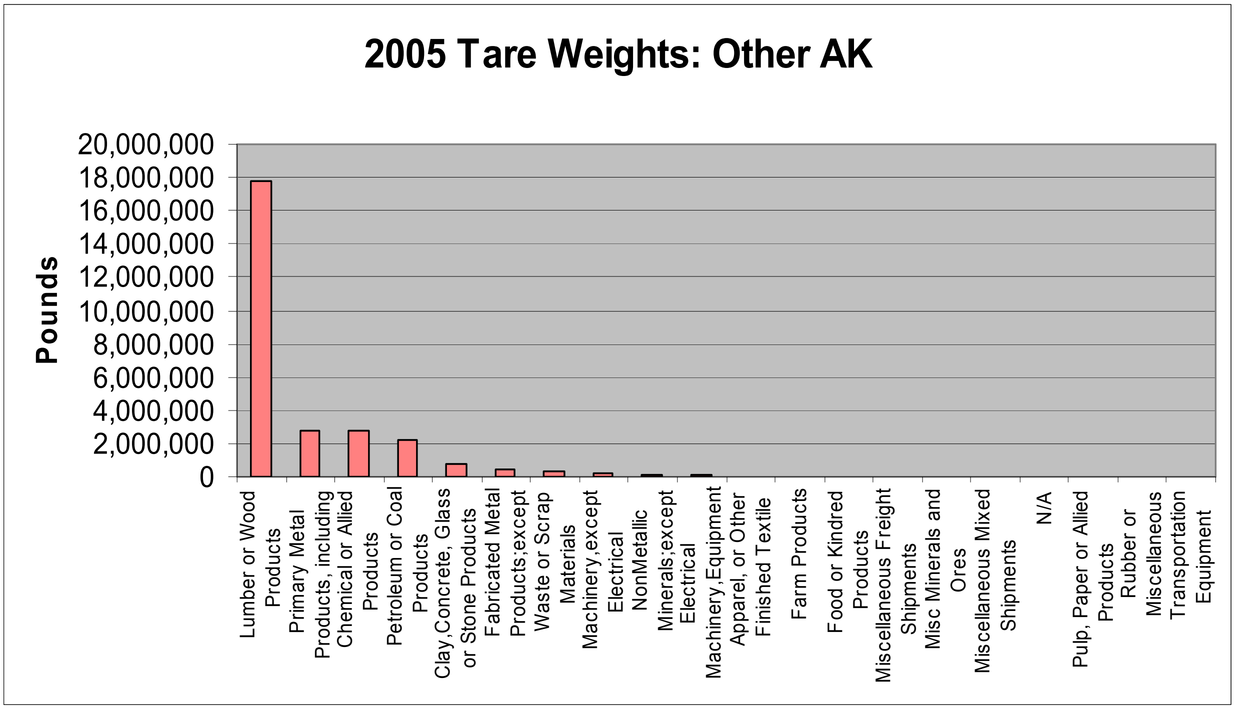


Figure 12: 2005 Tare Weights, Other Alaska

- Lumber or Wood (8,919 tons)
- Primary Metals (1,375 tons)
- Chemicals or Allied Products (1,358 tons)
- Petroleum or Coal Products (1,095 tons)
- Clay, Concrete, Glass or Stone Products (364 tons)

1.2.1.1 CURRENT SUPPORT TO NORTH SLOPE OIL ACTIVITIES

According ARR officials, in general, rail support to the North Slope oil patch, or the amount of freight and rail traffic that results from North Slope oil activity, has steadily decreased with the decrease in oil production. However, as evident in previous figures, these supplies still comprise a majority of rail commodities transported to Alaska.

Producer	Year	Materials/Equipment	Volume (in Tons)
ConocoPhillips	2005	Chemicals	32,228
	"	Drilling Tubular	25,720
	2004	Chemicals	32,228
	"	Drilling Tubular	5,168
BP	2005	Chemicals	40,285
	"	Drilling Tubular	32,150
	2004	Chemicals	40,285
	"	Drilling Tubular	6,460

Table 1: North Slope Producer Rail Volumes, 2004-2005

Table 1 reveals rail volumes reported by major North Slope producer Conoco Phillips (CPAI). As indicated, CPAI shipped approximately 37,796 tons of materials/equipment, in the form of chemicals and tubular. In most cases, CPAI purchases general operation, maintenance and construction materials from local vendors in Alaska. These materials are then delivered to consolidation points in Anchorage and Fairbanks. LTL (less than truckload) carriers then deliver the materials to Prudhoe Bay, Alaska. Additionally, CPAI has a consolidation facility in Seattle, Washington for items purchased in the Lower 48. Currently, these materials are moved through CPAI's LTL system and take four to five days to reach Anchorage.

Figures presented for BP in this table are based on estimates presented in ***Figure 7*** for well completion and estimated chemical and drill pipe amounts. Using this formula, BP used a calculated 46,745 tons of chemicals and tubular in 2004, compared to a higher figure of 72,435 tons in 2005. As indicated in Figure X, 2005 producer rail volumes correspond with an increase in total feet drilled on the North Slope for the corresponding year, with the highest recorded drilling footage since 1985.

Figure 13 highlight chemicals and tubular figures destined for Anchorage, Fairbanks and other Alaskan communities. A majority of rail shipments are transported for Fairbanks where they would be transferred and moved via truck to Prudhoe Bay.

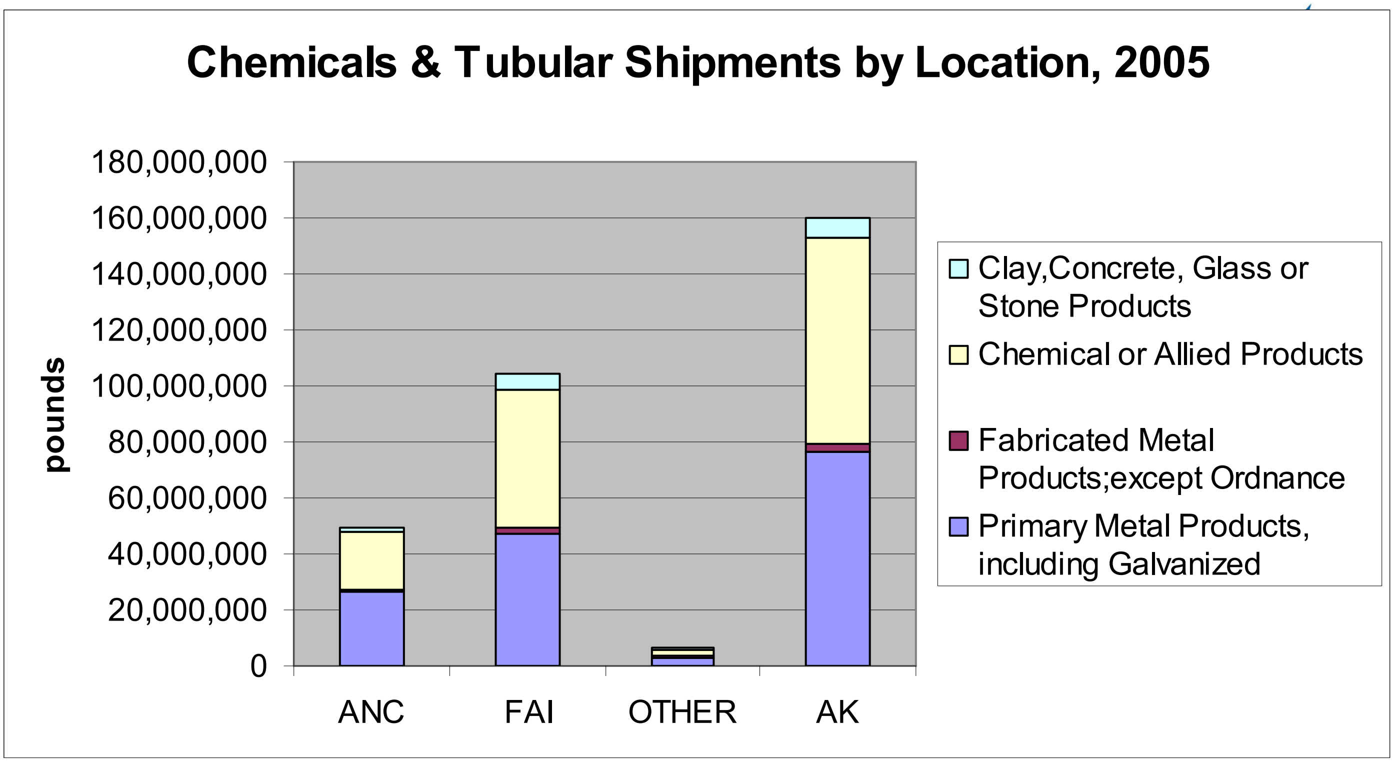


Figure 13: Chemical and Tubular Shipments by Location, 2005

The following paragraphs in outline form provide more detailed information on other components of current North Slope operation and maintenance materials/equipment needs and activity are detailed below:

Production Pipe: Currently, virtually all production pipe utilized by CPAI and BP on the North Slope comes into Fairbanks via rail in gondola cars. The pipe is all insulated/coated by Flowline Alaska and is then shipped by truck to Prudhoe Bay. The pipe originates in the Mid-West and Eastern United States and would be potentials for direct rail movement to Alaska if service were available. In 2005, CPAI used an estimated 8,577 tons of production pipe. BP representatives have estimated utilization of approximately 5,000 tons of production pipe for 2006.

Drill Steel/Drill Rigs: Drill steel and drilling mud is provided to producers by drilling contractors. As of this writing there are sixteen working rigs on the North Slope. Two more are being considered for modification, one for the Conoco Phillips heavy oil projects at Ugnu and West Sak, and the second for the Pioneer project at Oooguruk.

Independent Producers Drilling Activity: Currently four independent oil companies are actively exploring on the North Slope:

- Anadarko – Foothills
- FEX – Aklaq 1 & 2/Aklaqyaaq
- Kerr McGee – Nikiatchuq/Tuvaaq
- Pioneer –Ooogurk

Independents are expected to operate at 25% of the producers drilling activities in 2006. Forecasted production rates are provided in Section 1.3.2.

Low Sulfur Diesel: Estimated "slope-wide" diesel usage is 2,700 bbls per day. In the near future, it is expected that a hydro-treater will be placed on a topping plant in Prudhoe Bay to produce the fuels required for exploration, production and operations and maintenance for the entire North Slope.

Methanol: Currently, methanol used on the North Slope is being shipped into Alaska from Canada. It is rail barged to Alaska and delivered to Fairbanks via rail and transferred to truck for delivery to the North Slope. The current major source of methanol (Methanex) is closing its Canadian methanol plant and moving operations to Trinidad. It is thought that this may spur construction of a methanol /formaldehyde plant on the North Slope which may well reduce the overall chemical freight requirements identified earlier.

1.2.1.2 INCREASED RAIL ACTIVITY

Alaska Railroad capabilities and capacity to handle increased freight and traffic, is dependent upon three key elements of the rail system: rolling stock, capacity, and good rail. In these three areas, the Alaska Railroad is prepared for additional activity, including the increased activity that may be experienced as a result of building the Alaska Gas Pipeline. Additionally, the ARR is currently operating well below capacity, as overall loads have decreased over the last several years. For example, adding an additional five trains per day, over a three-year construction period for the Alaska Gasline, would add a considerable amount of volume and would not overburden current railroad operations. Increased volumes of freight may affect capacities at the ports or laydown yards, but would not interrupt rail flow. If the demand were to increase to 10 or more trains per week, this could be a challenge for the ARR. However, they would most likely add rolling stock via long-term lease, versus any other major construction or rail car purchases. As reported by Railroad staff, ARR is currently in the process of preparing and repairing track. This work is being done as a response to an almost 30 year backlog of maintenance, as well as potential Alaska Gas Pipeline activity.

In terms of individual car capacity, ARRC is currently restricted to a total car weight (weight of car plus revenue load) of 263,000 lbs. The ARRC is anticipating an increase to 286,000 lbs/car in the near term. The ARRC is capable is handling heavier loads. However, this results in slower service and requires a great deal of effort.

Presently, Conoco Phillips does not foresee increased rail use, unless there is a major construction project (e.g. Natural Gas Pipeline), or their drilling program dramatically increases. In terms of the possibility of movement of materials via rail from Seattle to Anchorage (currently being moved via an established LTL system), the company would look at both the time and expense of changing a well-established transport system.

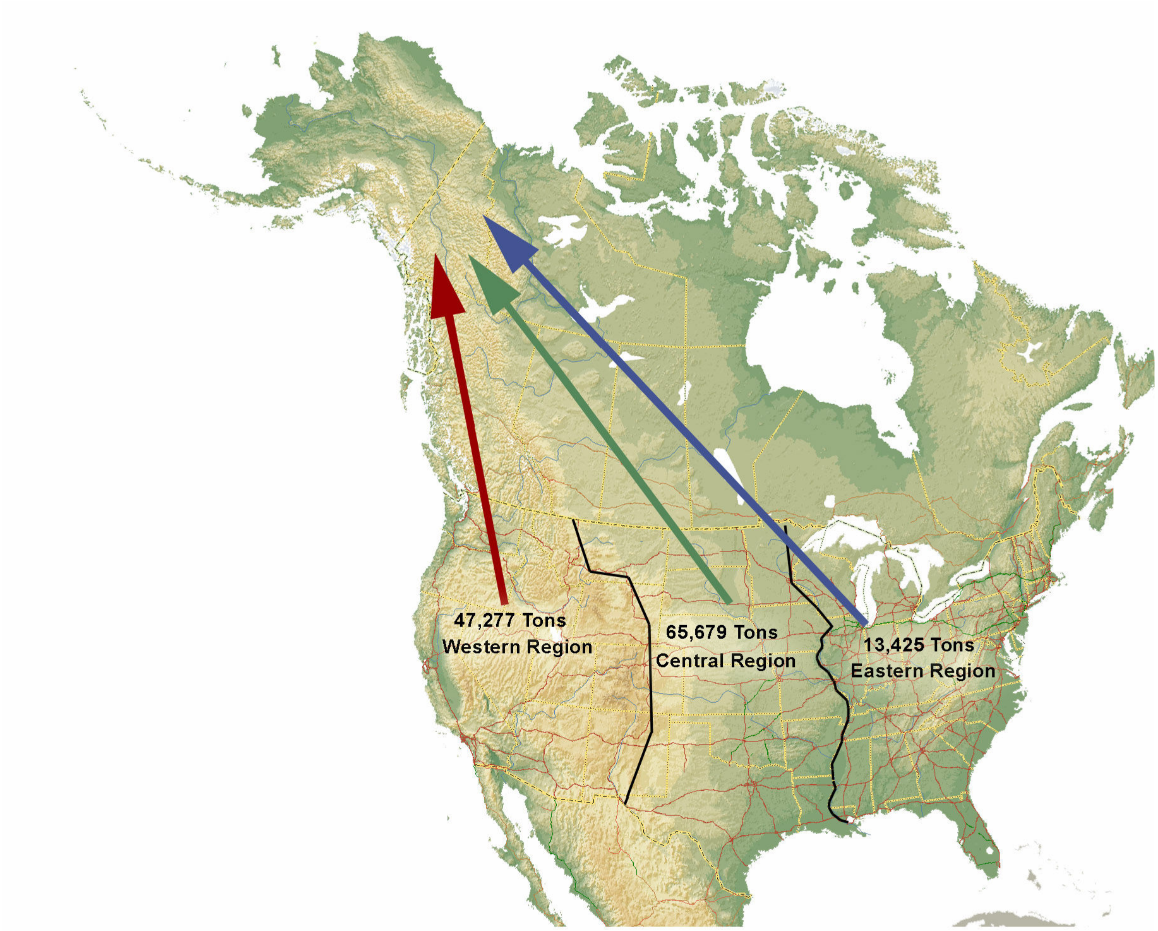


Figure 14: Commodities Transported via Rail by Region

Figure 14 shows rail commodity origins by region. It is predicted that all tonnage currently originating from the Central (roughly Rockies to Mississippi River) and Eastern (roughly East of Mississippi River) Regions of the Lower 48 and Canada would travel over the Alaska Canada Rail Link, approximately 79,194 tons. The remaining Western Region commodities would most likely continue to be shipped and consolidated in Western United States ports and then shipped or trucked north to Alaska. This point is further illustrated in ***Figure 15*** and ***Figure 16*** with approximately 82% of chemicals and approximately 68% of all tubulars shipped via rail originating from the Central and Eastern regions.

Figure 15: Chemicals Transported via Rail by Region

Figure 16: Tubulars Transported via Rail by Region

Table 2 reveals information provided by David Soquet with Halliburton Baroid, one of many drilling contractors working on the North Slope. This data indicates that the largest volume of material received by Baroid in 2005 (in preparation for both North Slope and Inlet oil and gas activity) was barium sulfate (i.e. barite). The bulk of Canadian barite, approximately 90%, is exported to the United States for use in drilling fluids. More specifically, Barite is mined in several places in British Columbia (Parsons), Alberta (Lethbridge) and processed in Watson Lake in theYukon Territory. It is then shipped to U.S. consolidation points. Additionally, there are mines in Ontario and Nova Scotia that are not utilized because of shipping costs to Alaska.

Material	From	% of total
Calcium Carbonate	California	9.85
Xantham Gum	Chicago	3.00
Barite (Barium Sulfate)	Nevada	63.08
All others	Houston	24.07

Table 2:Halliburton Baroid Chemicals Origins

Other points to consider in future studies, in terms of increased rail activity and current/future development on the North Slope include:

- Lay down yards
- Distance between fuel sources
- Bridges
- Maximum rail grade
- Pipe transport (in what form)
- Bed capacity
- Capacity changes along the railroad
- Tunnels and train loads

1.2.2 Roads/Truck Travel

Although somewhat dated information ***Figure 17*** shows truck traffic flow to and from Alaska and the Lower 48 in 1998. ***Figure 18*** provides a magnified look at truck traffic in Alaska, where it is evident that most traffic is concentrated in the Southcentral and Interior regions of the state. Additionally, there is a distinct line of activity along the Dalton Highway. Lastly, ***Figure 19*** shows estimated truck traffic for 2020.

Figure 17: Alaska Total Combined Truck Flows, 1998[1]

[1] *http://ops.fhwa.dot.gov/freight/freight_analysis/state_info/alaska/freightflow_ak.htm*

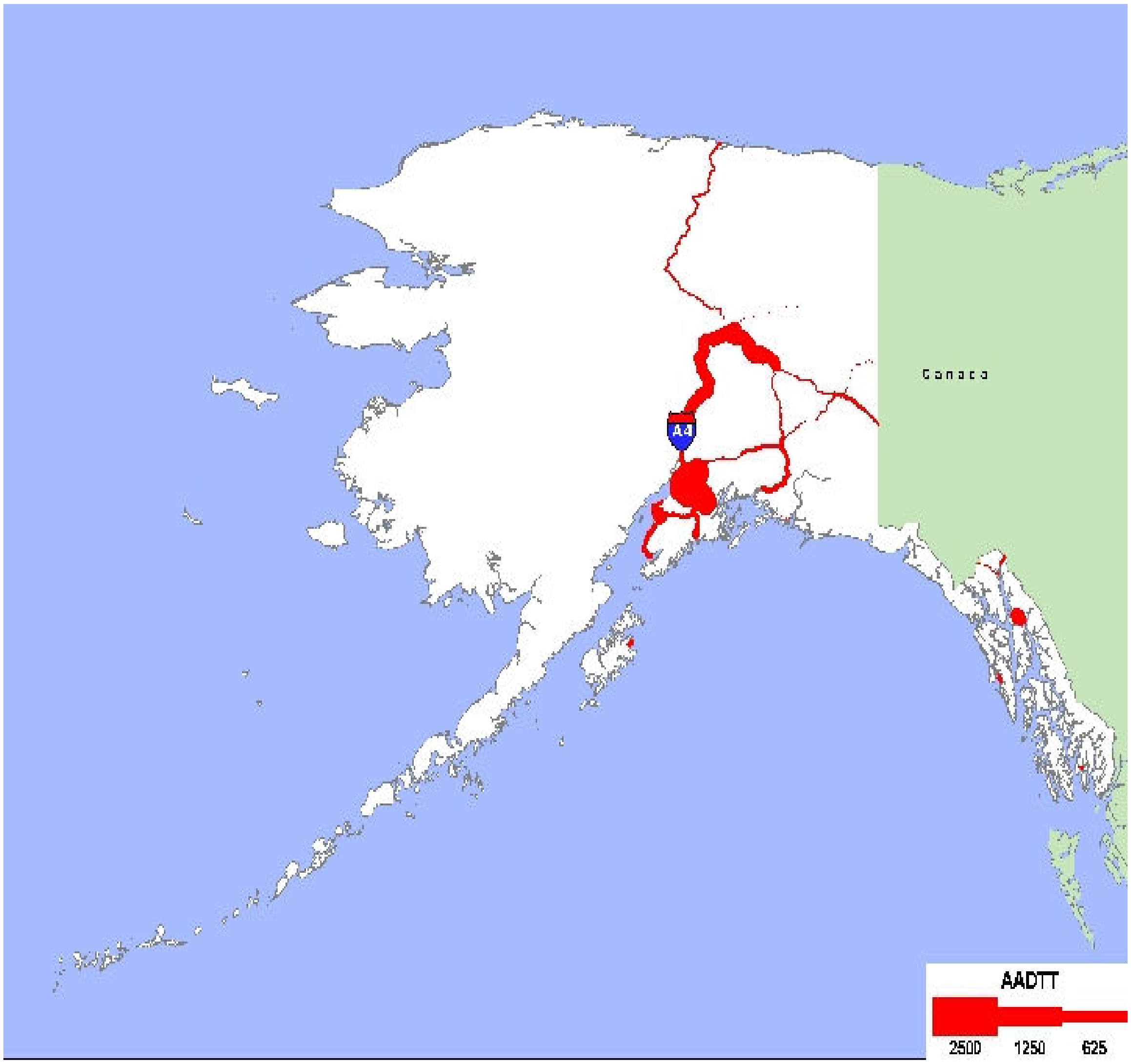


Figure 18: Estimated Average Annual Daily Truck Traffic, 1998[2]

[2] http://ops.fhwa.dot.gov/freight/freight_analysis/state_info/alaska/freightflow_ak.htm

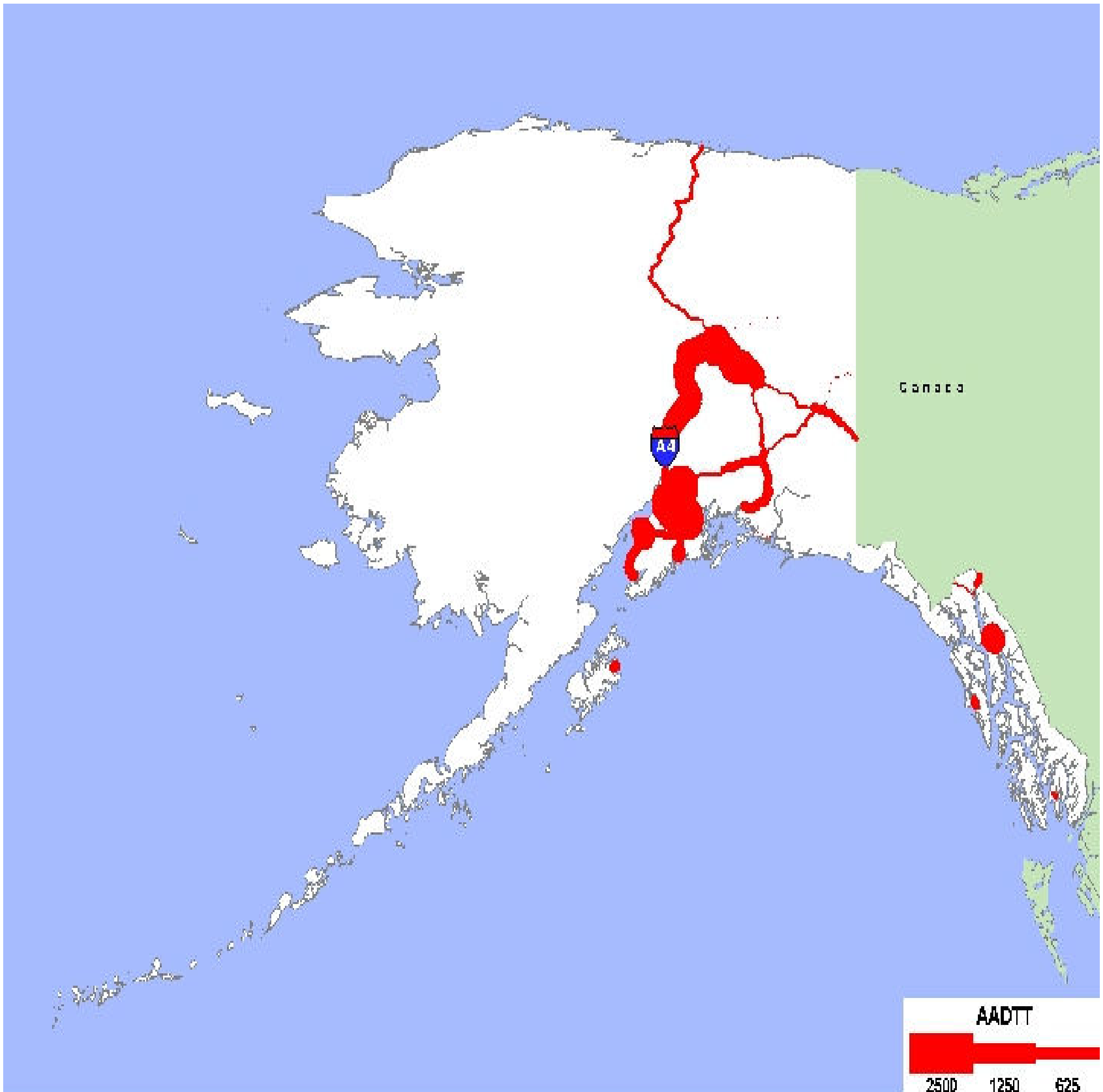


Figure 19: Estimated Average Annual Daily Truck Traffic, 2020[3]

[3] http://ops.fhwa.dot.gov/freight/freight_analysis/state_info/alaska/freightflow_ak.htm

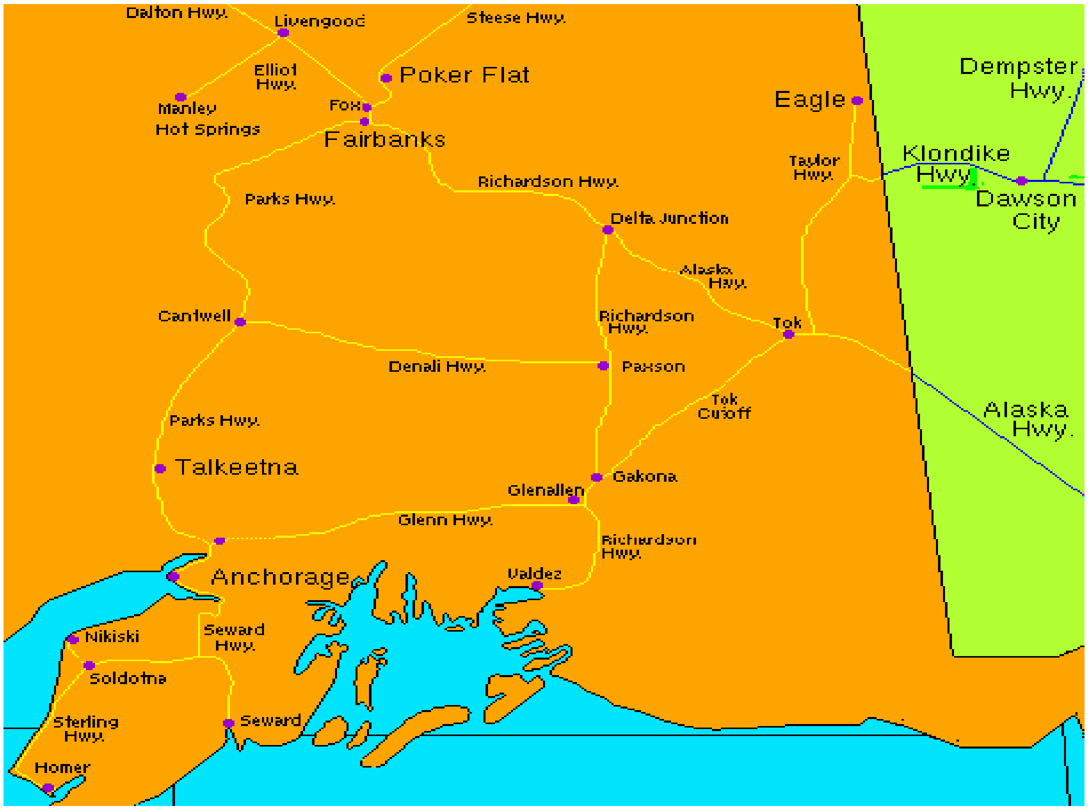


Figure 20: Alaska Highway System

As indicated in the discussion of present-day use of rail for North Slope oil patch and community needs, the Alaska road system currently plays a significant role in the current transport of materials and equipment to the North Slope. Using data available from the Alaska Department of Transportation and Public Facilities (DOT&PF), this section describes DOT&PF means for estimating highway conditions in Alaska, traffic volumes, road needs, as well as the current movement of goods via the existing road system in Alaska. This section will close with a summary of proposed road improvements and upgrades in connection with the Alaska Gas Pipeline (as one exampled of future North Slope development).

The routes of concern for this study are as follows (mapped in ***Figure 20***):

- Alaska Highway: Canadian border to Delta Junction, 200 miles
- Elliot/Dalton Highway: Fox to Livengood to Prudhoe Bay, 414 miles
- Glenn Highway: Tok to Anchorage, 328 miles
- Parks Highway: Anchorage to Fairbanks, 362 miles
- Richardson Highway: Glennallen to Fairbanks, 247 miles

Currently, there is a system of Permanent Traffic Recorders (PTR) dispersed throughout Alaska that are operated and maintained by ADOT&PF. These devises track traffic volumes, 24 hours a day. This data is then published in Annual Traffic Volume Reports. Some PTR sites have been upgraded to classification sites, including the Glenn and Parks

Highway routes, which capture more detailed information on the class of vehicles that pass a site. ***Table 3*** describes vehicle classes 5-13, all of which are considered commercial vehicles by the State of Alaska. As defined by the State of Alaska, a commercial vehicle is defined as "…a vehicle used in a business for the purpose of transporting persons, goods, or property, in addition to any vehicle with an unladen weight of over 10,000 pounds. Class 5 and above can be considered within the commercial vehicle range".

Single Unit	
Class 05	Delivery Trucks, Recreational Vehicles, Dump Trucks (2 axels, 6 tires)
Class 06	Dump Trucks, Recreational Vehicles (3 axles)
Class 07	Concrete Trucks, Fuel or Propane Delivery Trucks (4 or more axles)
Single Trailer	
Class 08	Tractor/Truck w/Trailer (3 or 4 axles)
Class 09	Tractor/Truck w/Trailer (5 axles)
Class 10	Tractor/Truck w/Trailer (6 or more axles)
Multi-Trailer	
Class 11	Tractor/Truck w/2 Trailers (5 axles)
Class 12	Tractor/Truck w/2 or more Trailers (6 axles)
Class 13	Tractor/Truck w/2 or more Trailers (7 or more axles)

Table 3: Vehicles Classes, Alaska Department of Transportation

Figure 21 and ***Figure 22*** how the total number of vehicles that traveled the Glenn and Parks Highways, 2000-2004. These figures capture the direction traveled, by month, by class of vehicle. Further analysis reveals that in 2004, an average 14% of vehicle travel on the Glenn Highway was commercial vehicles, with a winter months (September-May) average of 13% and a summer months (June-Aug) average of 15%. There is considerably less data available for the Parks Highway for 2004. An average over several years (2000-2004) for the Parks reveals that commercial vehicles comprise a monthly average of 15% of total vehicles. The average percentage of commercial vehicle for winter months was 17%, compared to approximately 14% during summer months.

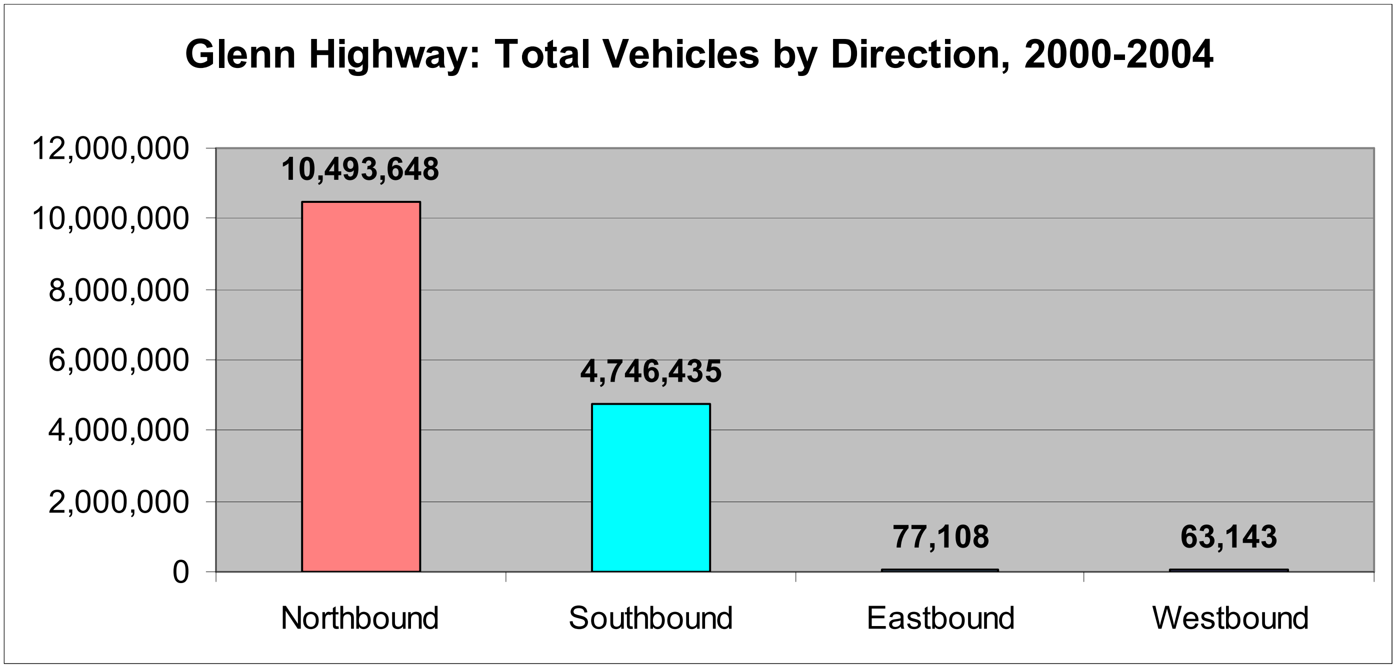


Figure 21: Glenn Highway, Total Vehicles by Direction, 2000-2004

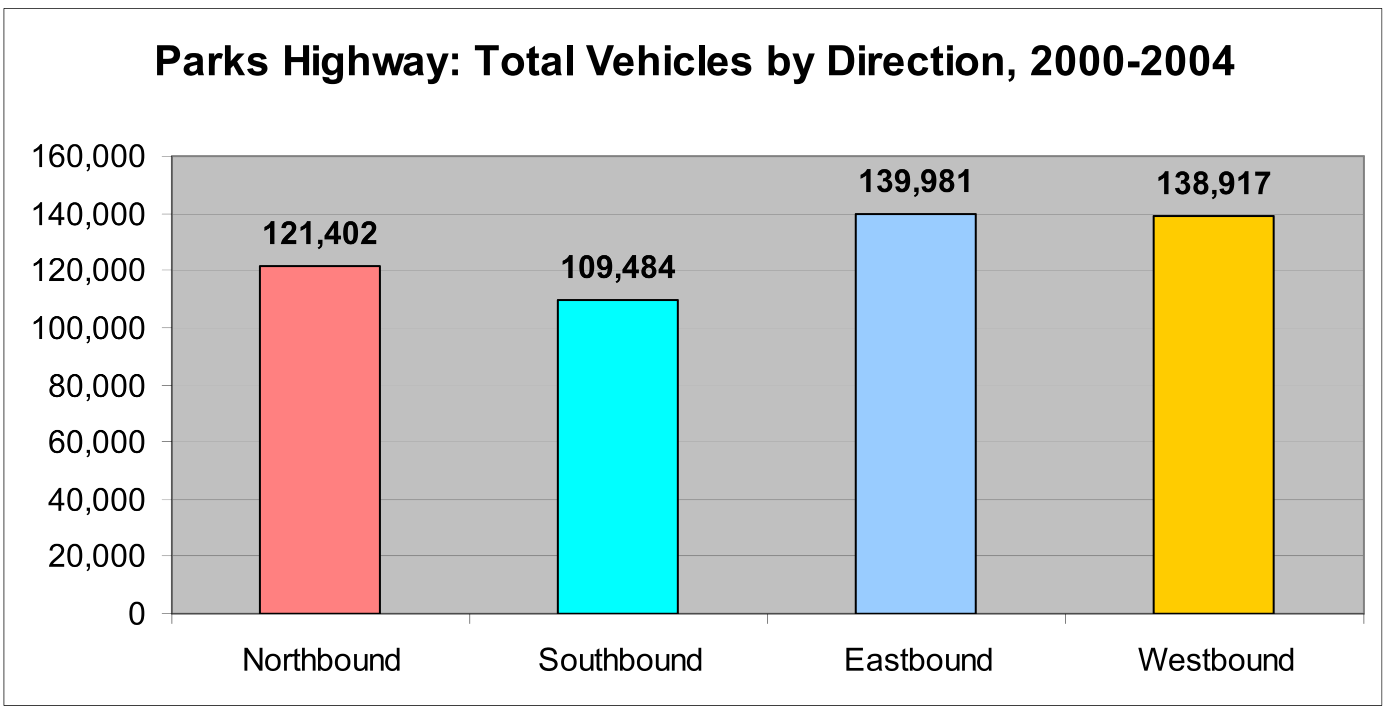


Figure 22: Parks Highway, Total Vehicles by Direction, 2000-2004

As revealed in 2004 traffic volume reports for the DOT-designated Central and Northern Regions of the state, the Glenn Highway saw the most vehicle miles at 1,456,333 miles, followed by the Parks Highway at 986,110 miles (***Figure 23***). ***Figure 24*** and ***Figure 25*** provide Annual Average Daily Traffic (AADT) on four study routes, once again indicating heavy travel on the Glenn and Parks Highways, 688,230 and 405,344 vehicles per day in 2004, respectively. This is compared to lower AADT numbers for the Richardson (1,912) and Alaska Highways (610). Lastly,

Figure 26 gives a general sense of vehicle travel by direction for the Glenn and Parks Highways, with the highest volume of traffic being experienced on the Glenn Highway in a northerly direction.

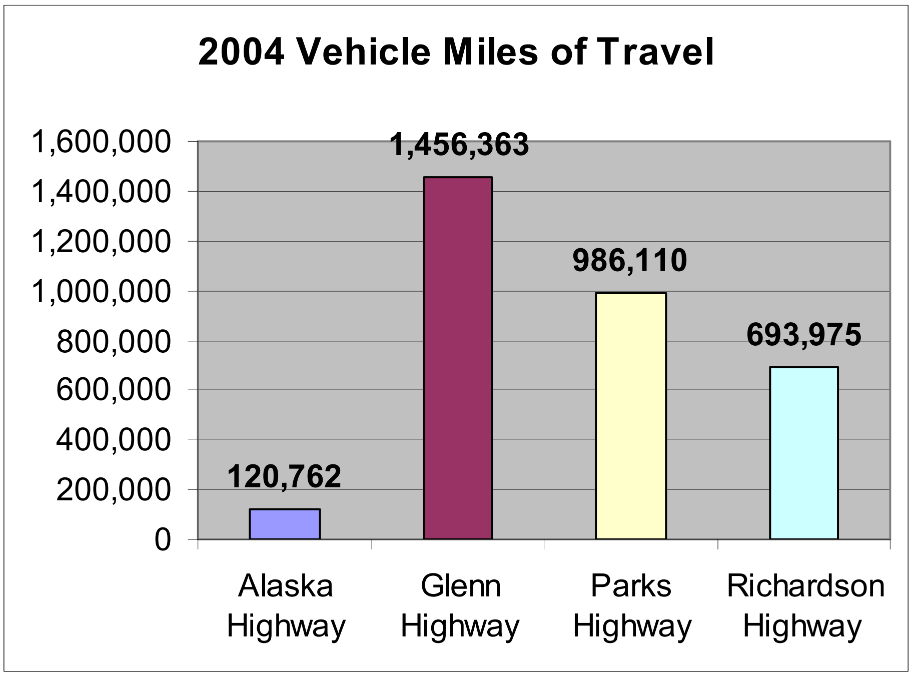


Figure 23: 2004 Vehicle Miles of Travel by Highway

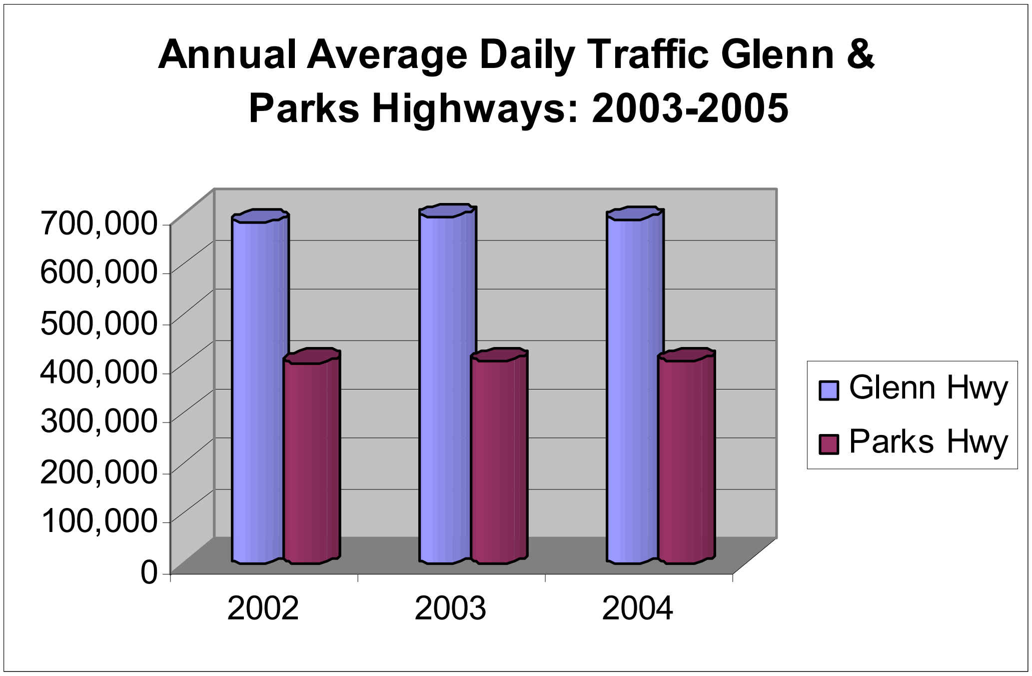


Figure 24: AADT, Glenn and Parks Highways, 2003-2005

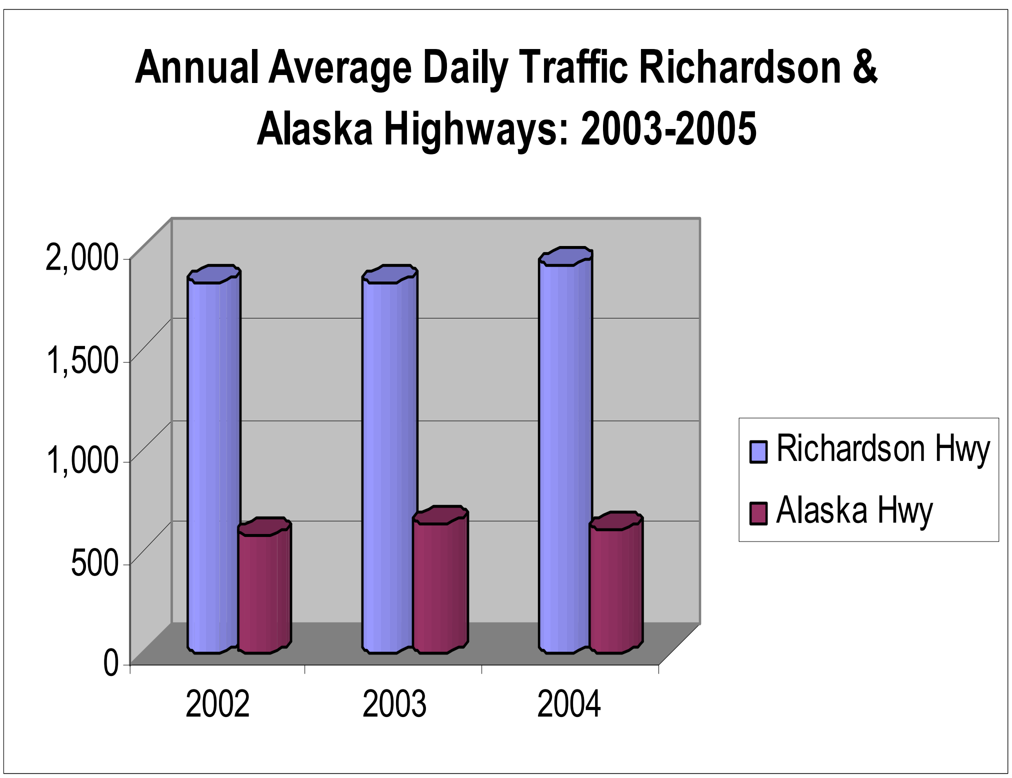
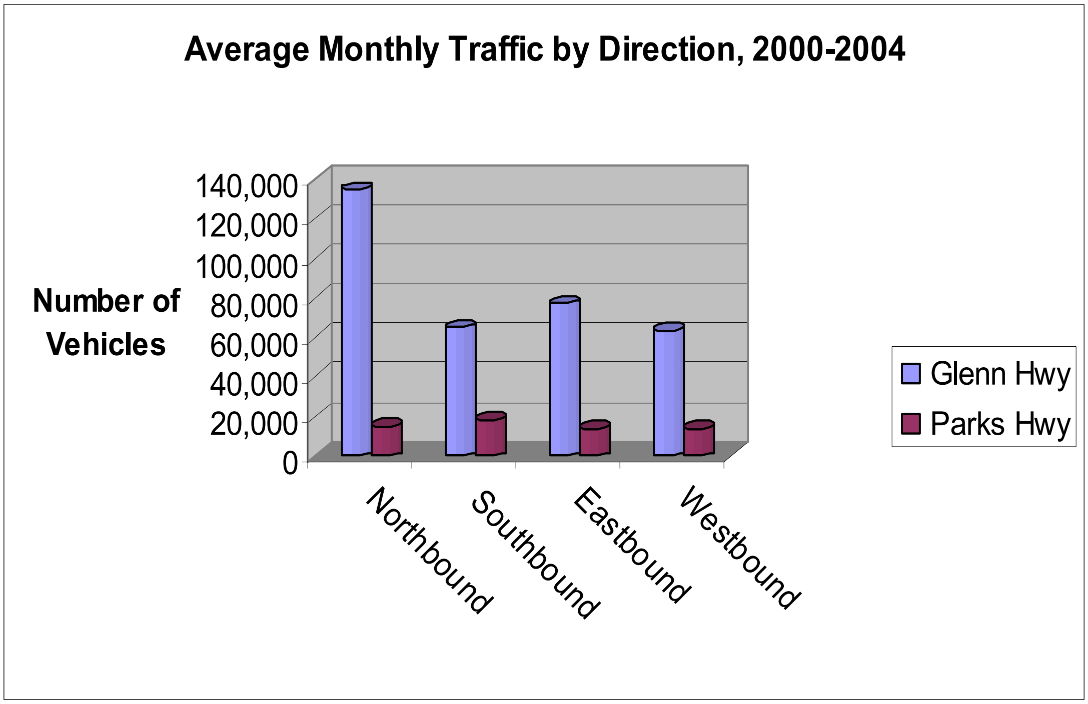


Figure 25: AADT, Richardson and Alaska Highways, 2003-2005



There are currently no permanent recording devices north of Fox, Alaska. However, according to DOT&PF Transportation Planner Donna Gardino, there are plans to place volume and class counters on the Dalton Highway in June of 2006 for a two-week period. In terms of the placement of PTRs on the route, the Department would like to include several within the scope of upcoming Dalton Highway projects. At this time, however, it is an issue of getting power to each site.

Other traffic measurements DOT&PF uses to monitor Alaska roads include weigh stations, Weigh-in-Motion (WIM) equipment, and temperature probes. Weigh-in-Motion sites are capable of capturing truck weight data. WIM equipment captures per axel data that is not being measured by current weigh station technology. There are currently 7 WIM sites located in areas within and outside of the Municipality of Anchorage. Sites of interest for this study are in Fox and Tok, detailed in ***Figure 27***, ***Figure 28***, followed by sample axle groups and affiliated weights and distances (*Table 4*).

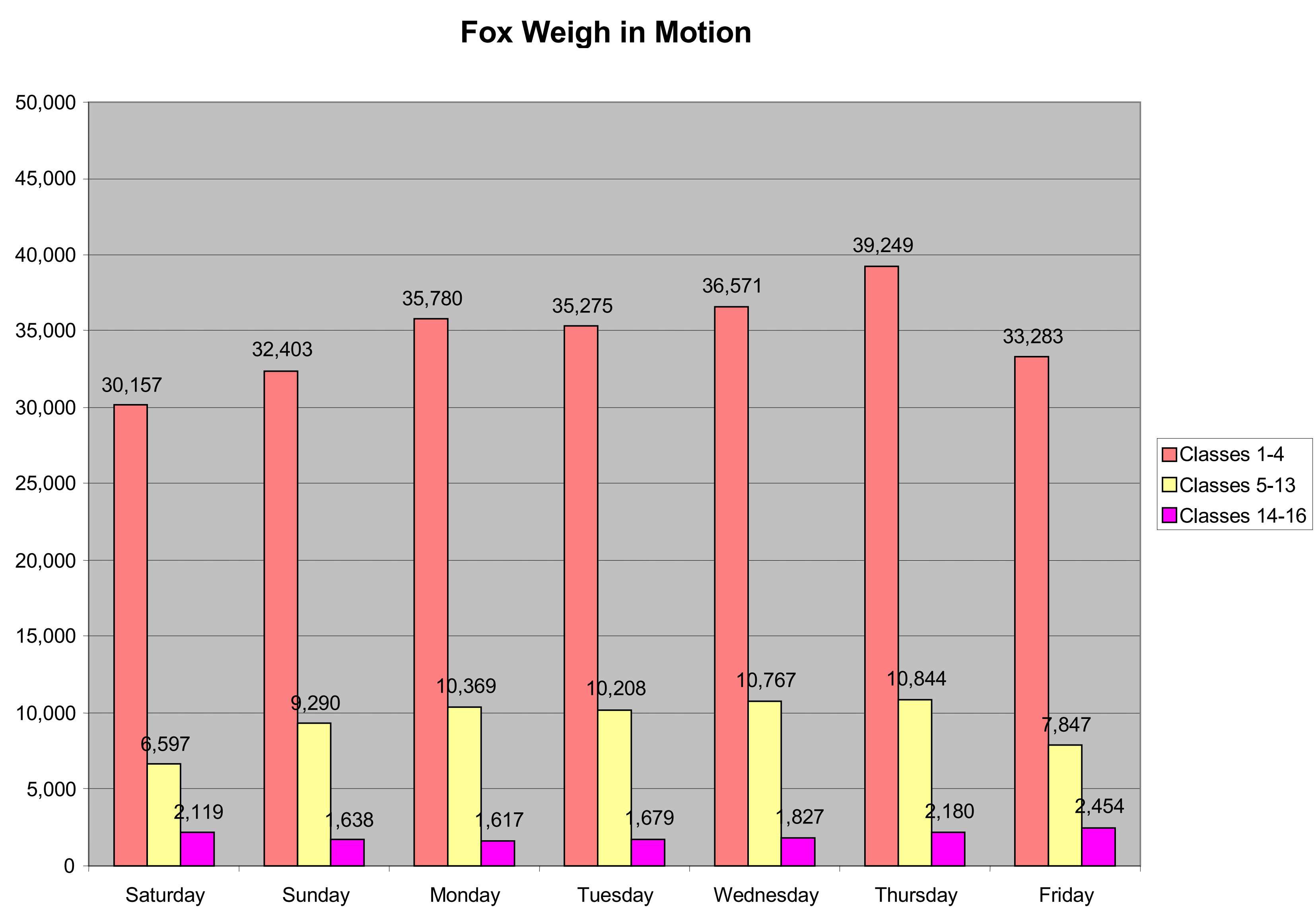


Figure 27: Fox W-I-M Data by Class and Day, October 2005 to March 2006

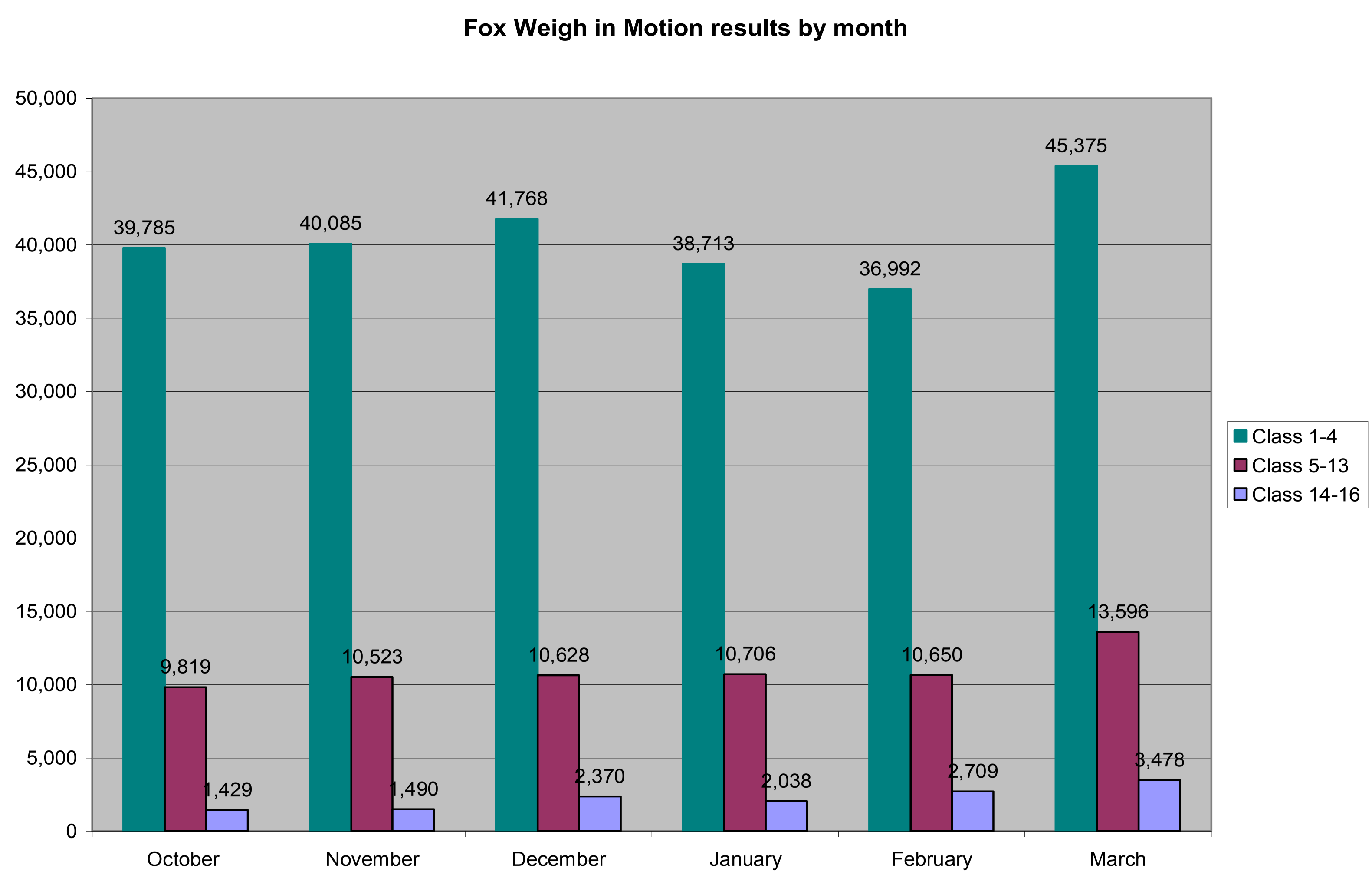


Figure 28: Fox W-I-M Data by Month/Class, October 2005 to March 2006

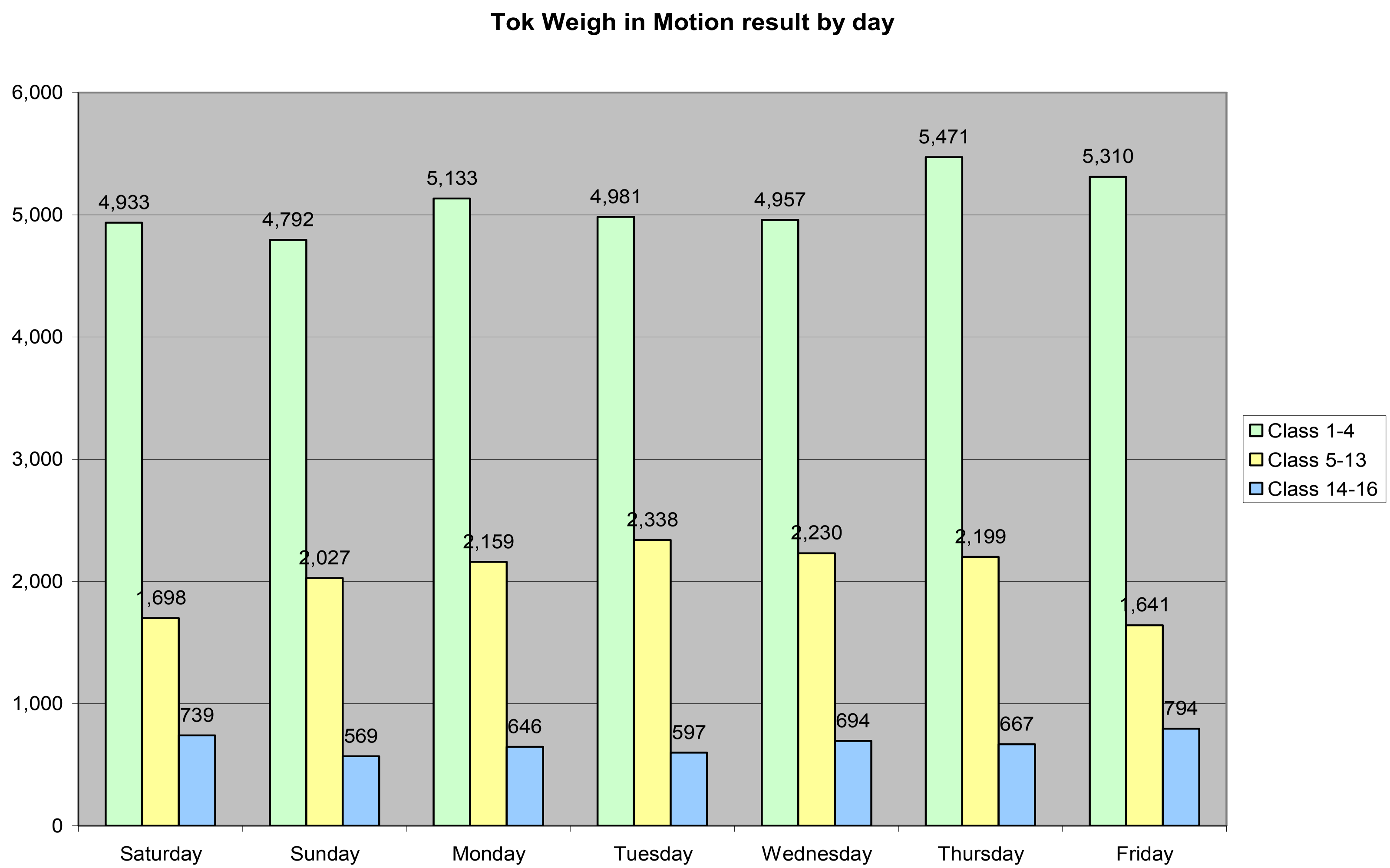


Figure 29: Tok W-I-M by Day/Class, October 2005 to March 2006

Figures 27-30 indicate that overall traffic northbound out of Tok is approximately 1/6 that of Tok for the days/months measured in 2005-2006. The two locations also differ in ratio of cars-to-truck traffic. Approximately 4 cars traveled out of Fox for every one truck, versus the 3 cars for every one truck that traveled north from Tok.

These figures also give some indication of the cycles of activity for each location by month and day. At Fox, the highest volume of traffic was experiences in March. In Tok, the highest volumes of traffic moved during the month of October (mostly Class 14-16, or recreational vehicles). Further examination shows that the highest percentage of truck traffic happened on Tuesday for Tok (highest car traffic also on this day), versus Thursdays for the Fox location (highest car traffic on Saturdays).

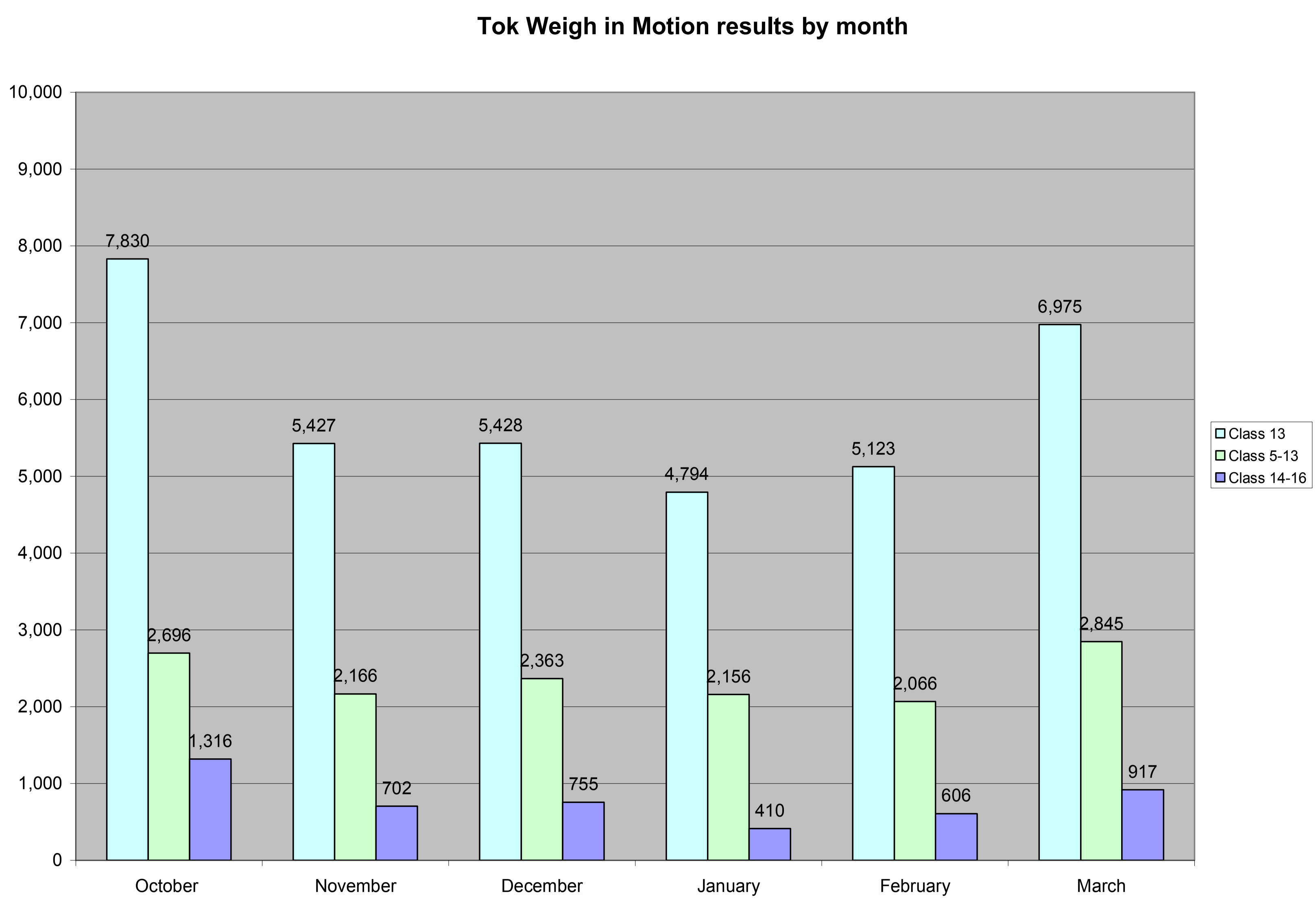
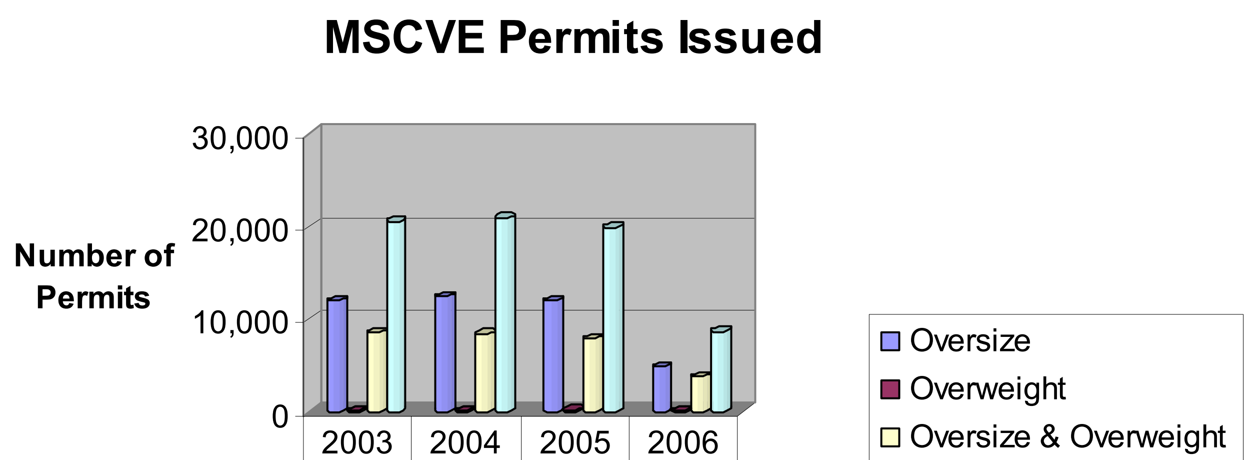


Figure 30: Tok W-I-M by Month/Class, October 2005 to March 2006

	Weight (pounds)	Distance
Single Axle	20,000	8'1" minimum spacing
2-Axle Group	38,000	3'6" minimum spacing
3-Axle Group	42,000	3'6" minimum spacing
4-Axle Group	50,000	3'6" minimum spacing

Table 4: Legal Vehicle Weights, Alaska Legal Resource Center

In addition to the Fox and Tok data described above, there is also some data on the Glenn Highway. However, WIM equipment is currently set up only in the outer most right lane of Glenn Highway. There are signs posted that direct trucks to the right, but DOT&PF is still uncertain how many trucks bypass the WIM equipment. The equipment was installed in 2004, but was not installed across the whole length of the highway. Therefore, that data is not presented in this chapter.



	2003	2004	2005	2006
Oversize	11,952	12,441	11,924	4,822
Overweight	66	117	132	84
Oversize & Overweight	8,533	8,352	7,862	3,712
Totals	20,551	20,910	19,918	8,618

Figure 31: MSCVE Permits Issued, 2003-2006

In addition to WIM sites, DOT&PF has 38 temperature probes located on the road system that help to determine weight restrictions on the road system. The Measurement Standards and Commercial Vehicles (MSCVE) Division of DOT&PF sets weights restrictions. Vehicles that are carrying extra weight must obtain special permits from MSCVE. The state does not forecast the number of permits to be issued; it is strictly a demand-driven program.

Figure 31 details the number of permits issued to oversize, overweight, and oversize/overweight vehicles, FY2003-2006. Most permitted traffic on Alaska highways during this period was oversize (41,139), followed by vehicles that were both oversize and overweight (28,459). Roughly 90-95% of permits were issued on an annual basis are for commercial vehicles. Additionally, from May 2004 to May 2005, 3,309 vehicles provided proof that they had paid a heavy vehicle use tax. Vehicles with a taxable gross weight of 55,000 pounds or more are subject to the federal tax.

Per an April 21, 2006 public notice issued by DOT&PF:

> Seasonal weight restrictions are imposed by ADOT&PF on the State Highway System for all vehicles over 10,000 GVW. Annual weight restrictions are used to reduce damage caused by heavy vehicles traveling on highways weakened during spring breakup conditions. The weight restrictions are stated as a percentage of legal allowable weight and are applied to the maximum axle load in accordance 17 AAC.25.013 (e).[4]
>
> Restrictions are very dependent upon weather and frost depth, but usually occur between mid-March and early June each year for Interior Alaska. Since these limitations may reduce the allowable gross vehicle weight by as much as 50%, ADOT&PF usually encourages heavy vehicles to transport as much freight as possible prior to the time the mid-March through early June window. All State routes, including the Dalton Highway are subject to these restrictions.
>
> Special conditions can be applied to the Parks Highway between the Glenn Highway and Fairbanks. These provisions can include axle road limits different from normal weight restrictions and also speed reductions, if required, in specific areas. As stated above, under certain circumstances, the State will issue overweight permits.

Figure 32 reveals approximate seasonal variations in travel on the Glenn and Parks Highways. There calculations indicate higher traffic volumes for the Glenn during winter months (89,165/month). The reverse seems to be true for the Parks Highway with almost 40% more traffic occurring in summer months, perhaps related to tourism travel to Denali National Park.

---

[4] **(e)** Except when an emergency requires immediate action, if the department determines that a highway may be damaged by a vehicle's weight, weight restrictions may be imposed after appropriate notice has been given to the public. When weight restrictions are imposed, they will be stated as a percentage of the legal allowable axle weights and applied to the maximum axle loading specified in this section. The weight on steering axles may not be restricted below 100 percent of the legal allowable axle weight. Unless approved by the department, a permit issued under 17 AAC 25.320 allowing overweight vehicles does not satisfy the requirements of this chapter in order to travel on weight-restricted highways during the period when weight restrictions are imposed, http://touchngo.com/lglcntr/akstats/AAC/Title17/Chapter025/Section013.htm.

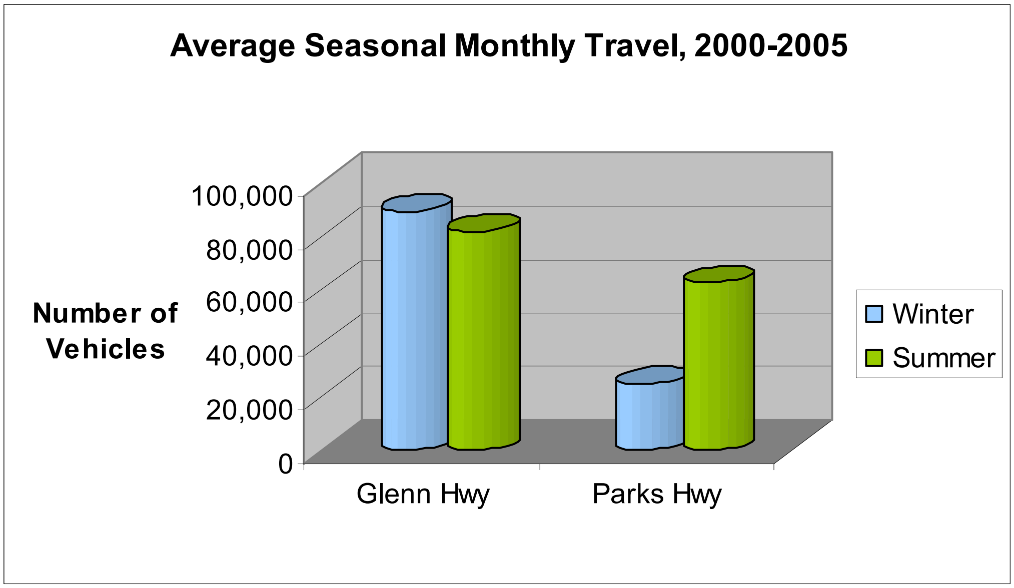


Figure 32: Average Season Monthly Travel, Glenn and Parks Highways, 2000-2005

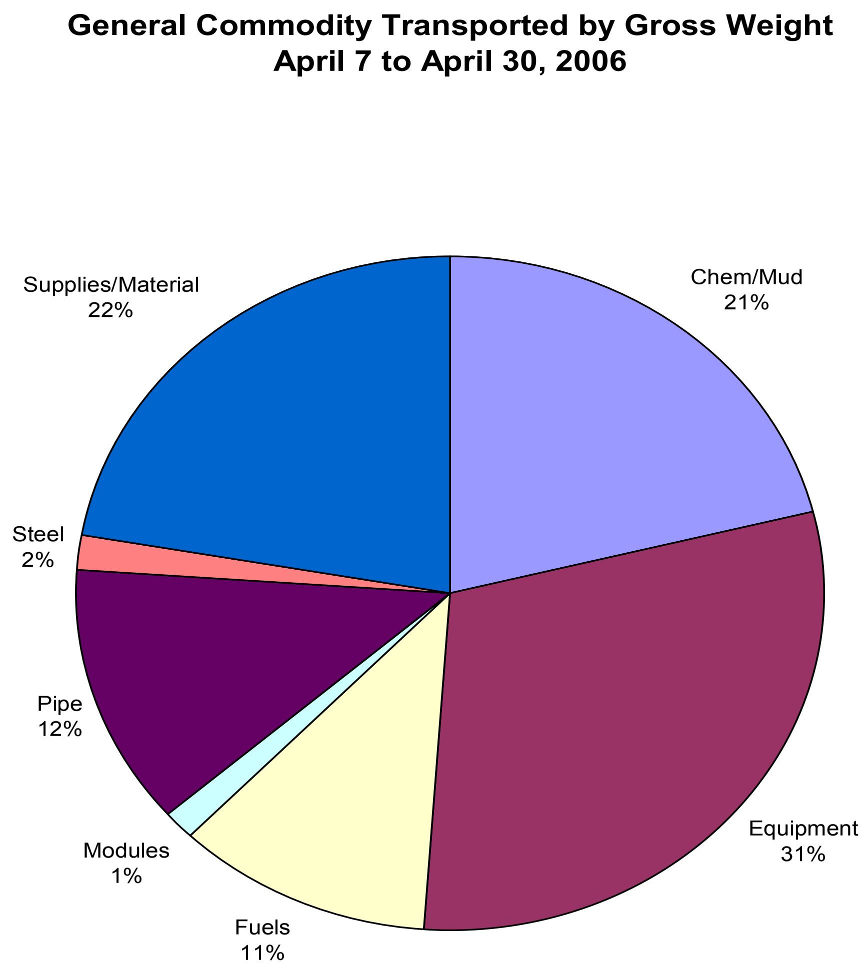
1.2.2.1 Supply to North Slope Oil Activity

In terms of support for current North Slope oil activity by road, the picture is less clear than described in Section X on the ARR. Commodity level data for trucking companies was last collected by the State of Alaska in 1987 as the *Bi-Annual Truck Weight Study*. Before that time, the State DOT&PF was required to collect data every two years by the Federal Highway Administration. What is known from interviews with major producers is that the following trucking companies transport the majority of chemicals and tubular to the North Slope:

- Carlile Transportation Systems
- Lynden Transport
- Weaver Bros., Inc.
- Sourdough Express

Although trucking companies did not respond to a request for commodity data, some data is available from a recent collection effort conducted by DOT&PF staff at the Fox, Alaska weigh station, for all trucks traveling to Prudhoe Bay. ***Figure 33*** and ***Figure 34*** represent data collected at the Fox, Alaska weight station, April 6th – April 30th, 2006.

Figure 33: General Commodity Transported by Gross Weight, April 7 - April 30, 2006

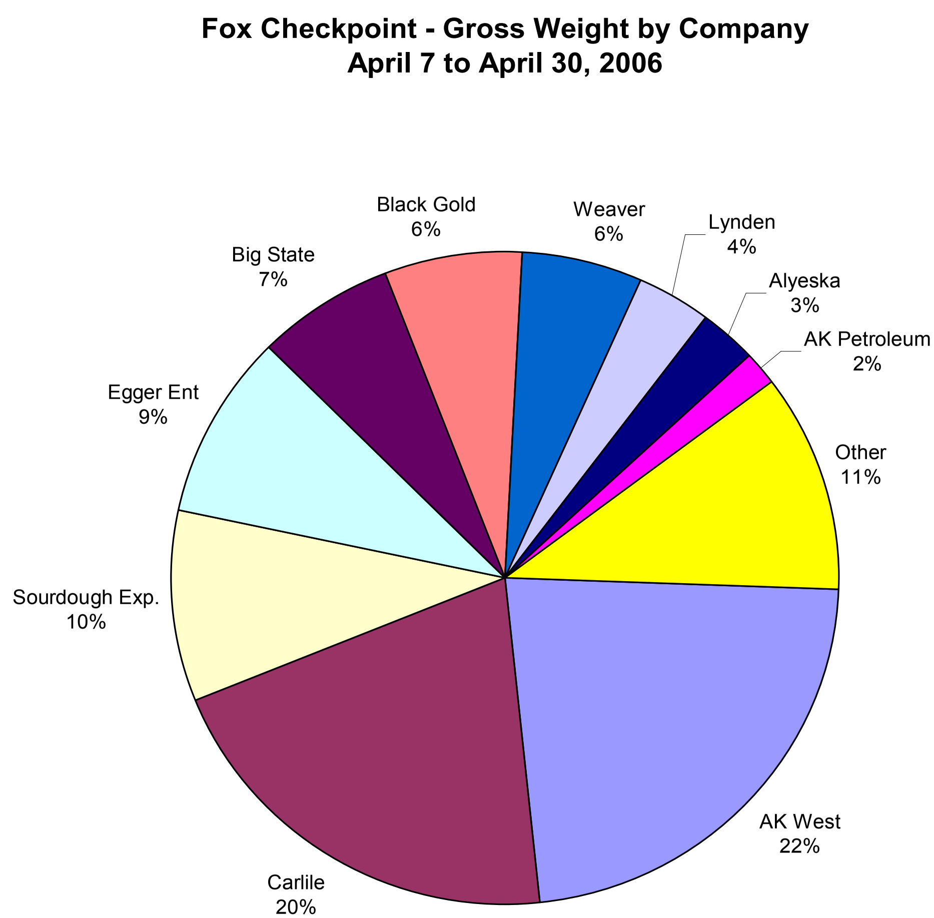


As indicated by , the majority of commodities that were trucked to the North Slope out of Fairbanks during this three-week period were equipment (31%), supplies/materials (22%), and chemicals/mud (21%). Pipe and steel comprised approximately 14% of the total volume moved via truck during this time. These figures, although helpful in terms of shedding light on chemical/tubular volumes moved via truck, may be somewhat skewed. In March of 2006, a spill of over 200,000 gallons of crude was discovered on the North Slope. This stopped North Slope production for over a month, as clean up crews worked to recover spilled crude. This unusual activity may be reflected in figures for the month of April, as work crews continued clean up efforts.

In addition to commodity level volumes, the Fox Weigh Station DOT&PF staff also logged each truckload by trucking company. As depicted in ***Figure 34***, the top five trucking companies by weight of commodities hauled to the North were as follows:

- AK West (22%)
- Carlile (20%)
- Sourdough Express (10%)
- Egger Enterprises (9%)
- Big State (7%)

Figure 34: Fox Checkpoint, Gross Weight by Company, April 7 – April 30, 2006



In terms of increased activity on the Alaska Highway System, a November 2004 study of the effect of gas pipeline construction on local communities conducted by Information Insights for the Municipal Advisory Group listed the following road improvements and upgrades.

Location	**Type of Upgrade**
Dalton Highway (Roads)	Highway improvements between Livengood and Prudhoe Bay
Elliot/Steese Highway (Bridges)	Address clearance and load-bearing issues
Richardson (Bridges)	Bridges between Fairbanks & Delta Junction
Richardson Highway (Road)	Highway Improvements
Alaska Highway (Bridges)	Highway Improvements
Glenn/Parks Highways (Bridges)	One overpass and several bridge upgrades between Anchorage and Fairbanks
Haines Highway (Bridges + Road)	One bridge replacement, highway improvements

Table 5: Potential Highway Upgrades with Alaska Gasline Construction

As suggested in truck flow maps, Southcentral and Interior Alaska are experiencing heavy traffic flows, with congestion issues in more populated areas, such as Anchorage and the Matanuska-Susitna Valley. The proposed Alaska Canada Rail Link (ACRL) could potentially alleviate some of this vehicle traffic on the Alaska road system. However, rail traffic volumes could increase, potentially causing bottlenecks in other areas of the state, such as Fairbanks, along the Elliot, Steese and Dalton Highways.

Additionally, according to Special Projects Administrator for DOT&PF Mark Taylor, the State has commissioned a special report to look at all routes that could be utilized for gasline logistics and potential impacts to Alaska highways. Per Taylor, the report divides the highway system into individual segments and identifies work that must be done to accommodate gasline traffic and the movement of goods, including highway and bridge upgrades. As of May 2006, the report was still in draft form and circulating among the major North Slope producers for comment.

Further analysis should consider different scenarios for the life of the Alaska Highway System if the ACRL was not built, as well as the effect of commercial vehicle traffic on traffic movement during peak summer tourism months.

1.2.3 Ports and Multimodal Transport

1.2.3.1 PORTS

This section will address port issues and multimodal transport as they relate to current support for oil and gas operation and maintenance on the North Slope. In a separate section of the ACRL Feasibility Study, Phase I, DKA Marketing has provided a detailed analysis of multimodal port access. In that analysis DKA Marketing identifies regions of Alaska and Canada that are served, or could potentially be served by specific ports or terminals. The DKA report lists each port's current activity and capacity/potential. In Alaska, relevant ports are as follows:

- Port of Anchorage
- Port MacKenzie
- Port of Seward
- Port of Whittier
- Port of Valdez
- Port of Skagway
- Port of Haines

What follows is a brief overview of the commodities received by Alaskan ports, and the relationship to current support to North Slope oil and gas. As mentioned above, the capacity and potential of each port is covered in detail in the DKA Marketing report, information not repeated here, except to mention commodity movement where no other information was available. As a backdrop to individual port data, ***Figure 35*** provides total domestic water flows to and from Alaska in 1998. As evidenced here, the majority of port traffic moves to/from Alaska and Washington and California ports.

Figure 35: Alaska Total Domestic Water Flows, 1998[5]

[5] *http://ops.fhwa.dot.gov/freight/freight_analysis/state_info/alaska/freightflow_ak.htm*

Port of Anchorage

Figure 36 depicts Port of Anchorage (POA) annual tonnage 1996-2004. The top three commodities from 1996-1996 were vans/flats/containers (annual average of 1,515,990 tons), bulk petroleum (annual average of 1,265,145 tons), and cement (annual average of 89,668 tons). Years1999-2004 saw big jumps in shipments of rail rack petroleum (annual average of 1,142,539 tons).

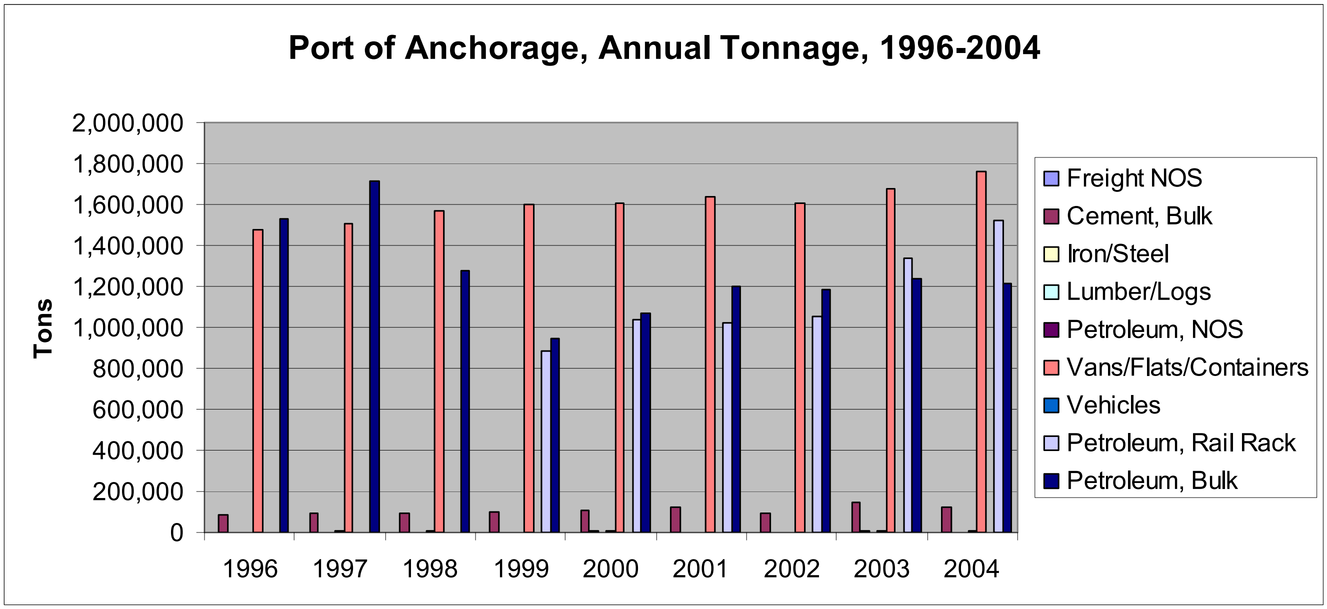


Figure 36:Port of Anchorage, Annual Tonnage, 1996-2004[6]

The POA is currently congested and limited by port capacity and on-off loading equipment. It is not expected that the POA would be utilized for increased and future development projects on the North Slope. . Preferential berthing status given to Horizon and Tote coupled with the overcrowded northbound highways out of Anchorage. However, the Port continues efforts to expand with plans in place to complete all expansion-related projects by 2011.

Port MacKenzie

According to Port Director Marc Van Dongen, Port MacKenzie, exported approximately 154,000 tons of commodities in 2005 during its first year of operations. The 154,000 tons was comprised mostly of wood chips, with some manufactured housing, as well as pump modules for Alyeska Pipeline and electrical modules for BP's North Slope operations. The Port is expected to start exporting sand and gravel during the summer of 2006. As Director Van Dongen noted, the port will be used primarily for exporting Mat-Su Valley's natural resources.

[6] *http://www.muni.org/port/*

Port of Seward

Karen Morrissey, Director of Real Estate for the Alaska Railroad (based in Seward), offered to compile tonnage information given the dollar amount of wharfage rates for the City of Seward. This information will be available in June 2006 for the year 2005. City of Seward wharfage rates listed in ***Table 6*** provide a basic understanding of commodities that move in and out of the Seward location.

Schedule of standard rates: Except as otherwise specifically provided, rates are in dollars per ton, or per 40 cubic feet.	
Commodity	**Wharfage rate**
Freight NOS	3.00
Scrap (iron, steel)	3.00
Raw fish, unprocessed	$3.00
Poles, logs, cants or cut finished lumber per MBM (Note: 2000 lbs shall be deemed 1 MBM)	$3.00
Petroleum products (inbound) per barrel	$.17
Petroleum products (outbound) per barrel	$.24
Petroleum products (gasoline) per gallon	$.01
Plastic material	$4.00
Explosives	$25.00
Vans or containers (net contents weight)	$2.00
Vehicles (gross vehicle weight)	$5.00
Bulk gravel	$.25
Bulk salt	$.85

Table 6: Wharfage Rates, City of Seward[7]

Port of Whittier

As reported in the DKA Marketing description of the Port of Whittier, the general and project cargo that flows in/out of Whittier accounts for approximately 25% of the Alaska Railroad Corporation's statewide freight service. Specific commodity data for the Port of Whittier is not available at this time.

[7] *http://www.cityofseward.net/harbor/page24.html*

Port of Valdez

According to Port Operations Supervisor Diane Kinney, 35,114 tons of cargo was shipped in 2004 in/out of Valdez. And additional 22,546 bone dry units (bdu) of wood chips were shipped from the port. As of October 2005, approximately 37,793 tons of cargo had moved in/out of the Port of Valdez and no wood chips were shipped. Although the port does not track cargo by commodity, Port Operations Supervisor Kinney reported that the majority of cargo is comprised of construction materials, seafood processing supplies and some household goods.

Port of Skagway

According to the Skagway Chamber of Commerce website, the Port of Skagway is a year-round transportation hub. The principal cargoes for the Port are bulk ore (export), general and barge container freight (inbound), petroleum (inbound) and wood products (outbound), as well as passengers. The Port also supports the mining industry as heavy equipment and machinery move through en route to northern parts of the state. Specific commodity data for the Port of Skagway is not available at this time.

Port of Haines

As reported in the DKA Marketing description of the Port of Haines, there is very little activity at the Lutak City Dock, the dock used for tanker barge shipments of petroleum products, as well as shipments of containers and general cargo. Specific commodity data for the Port of Haines is not available at this time.

From diversity of port data presented above, it is difficult to determine to what degree Alaska's port support the movement of materials and equipment to the North Slope for the oil operations and maintenance. Some figures may be hidden in more general freight terms for containers, cargo, vans, flats, etc. These data are more apparent in the ARR data presented earlier. Future research should investigate this issue in more detail, as well as commodity flows for the Prudhoe Bay Dock.

Lastly, as a point of interest and perhaps comment on the current capacity of Alaska's ports/harbors, in a December 6, 2005 speech to the U.S. Senate Foreign Relations Subcommittee of East Asia and the Pacific, Director of Pacific Operations of the Transportation Institute, Richard Berkowitz stated:

> In order to improve its potential for such trade {referring to trade with Asian countries], Alaskans should seek ways to improve their ports and harbors to better accommodate bulk vessels. Alaska's ports tend to be plagued by shallow harbors, significant tidal changes, difficult sea/weather conditions, and severe ice restrictions.

1.2.3.2 Multi-Modal Transport

In terms of multi/intermodal transportation, ***Figure 37*** provides an overview of shipments made by mode within, from and to the state of Alaska in 2002. As indicated, most shipments made within and to the state were moved via truck, rail, and by water, with less than 400,000 tons moving by multiple modes. Shipments made to the state were also more likely to move via truck, rail, or via intermodal transportation, defined by the Federal Highway Administration as the U.S. Postal Service, courier shipments and all intermodal combinations other than truck/rail and air/truck.

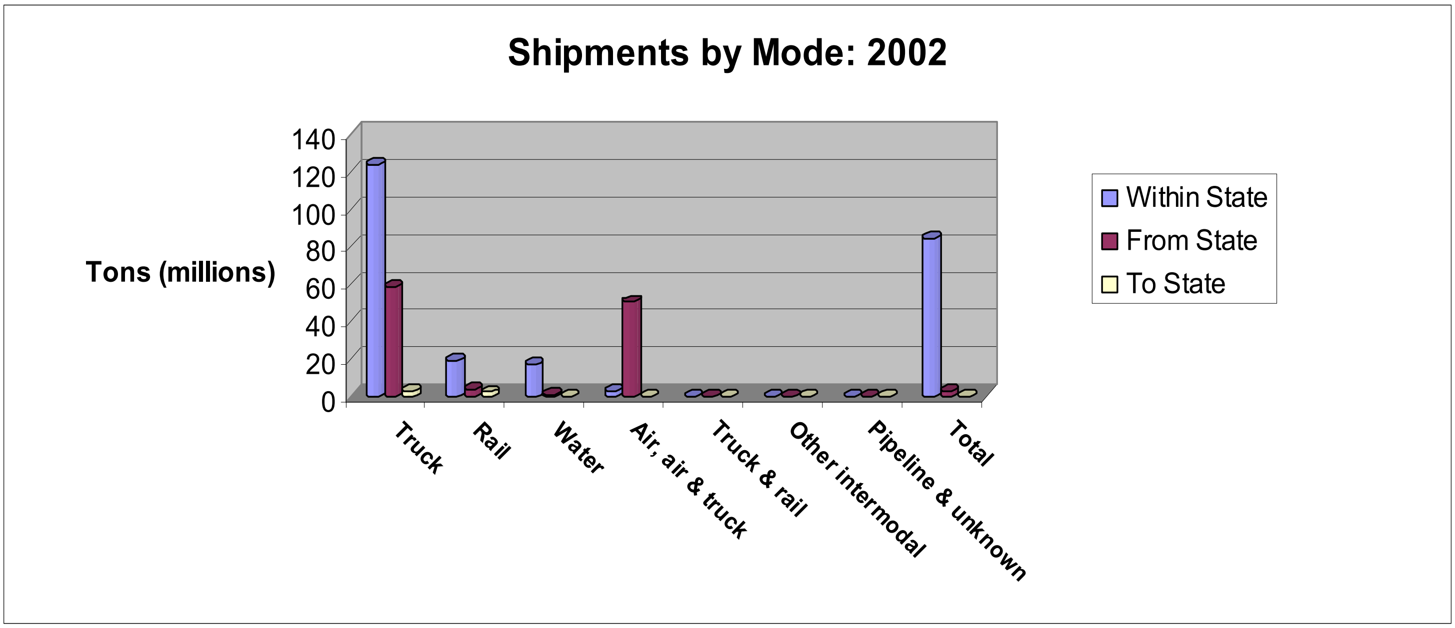


Figure 37: Shipment by Mode, 2002[8]

Table 7 identifies the top five commodities transported within, from, and to Alaska in 2002, while ***Table 8*** provides shipment forecasts for 2010 and 2020 by transportation mode and destination. Over 400,000 tons of chemicals products were shipped to Alaska

[8] Federal Highway Administration

in 2002. This figure may help to explain chemical shipments that cannot be explained by rail and port data.

Top Commodities: 2002					
Tons (millions)					
Within State		From State		To State	
Crude petroleum	81.3	Crude petroleum	49.1	Furniture	0.4
Gravel	13.7	Coal, n.e.c.	3.4	Chemical prods.	0.4
Gasoline	8.2	Fertilizers	1.7	Nonmetal min. prods.	0.4
Coal, n.e.c.	4.3	Base metals	0.8	Gasoline	0.3
Fuel oils	3.9	Logs	0.8	Articles-base metal	0.3
Total	**123.6**	**Total**	**58.5**	**Total**	**3.4**

Table 7: Alaska Top Commodities Shipped, 2002[9]

There are two major barge operators, and their affiliated subcontractors, that act as product consolidators and distributors in Alaska (via truck). They are as follows:

- Horizon Lines
  - Pacific Alaska Forwarders
  - Span Alaska Transportation

- TOTE
  - Lynden
  - American Fast Freight

Shipment Forecasts To, From, Within Alaska		
	2010	**2020**
State Total	**83**	**103**
By Mode		
Air	1.3	1.9
Highway	16	21
Other	2.8	3.4
Rail	NA	NA
Water	66	77
By Destination/Market		
Domestic	72	89
International	11	14

Table 8: Shipment Forecasts To, From, Within Alaska, 2010 and 2020[10]

Again, as was true for port data, without complete data sets, it is unclear exactly what percentage of chemicals and tubular are shipped via different intermodal combinations. However, given the detailed ARR data, it seems that these commodities move

[9] Federal Highway Administration
[10] Federal Highway Administration

predominantly via train, and at some stage, are transported to truck (unless sealifted or flown to Prudhoe Bay).

1.3 Future North Slope Oil and Gas Development

This section describes potential oil and gas development on the North Slope, including the following major projects/project areas:

- Alaska Gas Pipeline Construction
- Viscous Oil
- ANWR/NPRA/Foothills

Subsections include a description of each development and potential equipment and materials need that could be transported via rail.

1.3.1 Alaska Gas Pipeline Construction Data

The following outline provides data on the proposed Alaska Gas Pipeline Construction. This information was provided by BP and CPAI representatives during the spring of 2006.

Schedule: First gas delivered in nine years from project commencement. Currently anticipating a three-year construction season with the majority of activity taking place during winter months. Years one through six will be dedicated to project planning and engineering, permitting, long-lead time material ordering, contractor selection, surveying and general mobilization. A "pre-application" to FERC is required to be delivered on or about 4/20/06 to qualify for Federal Guaranties. A full FERC application is expected within 18 months.

Pipeline Design Rate: 4.5 bcfd

Expansion Potential: 5.6 bcdf

Compressor Stations: 24 – 28*

Total Pipeline Horsepower: 1.2 – 1.4 million*

Tons of Steel: 5 – 6 million*

Construction Staff Hours: 50 million +*

Peak Employment: 28,000*

Projected Equipment Requirements*:

- 134 Loaders

- 275 Automatic Welders
- 665 Sidebooms
- 18 Trenchers
- 250 Backhoes
- 236 Large Dozers
- 125 Stringing Tractors
- 1,300 Pickups
- 230 Buses

Note: This list of equipment was provided by Conoco Phillips and seems to omit much equipment which will be needed to complete this project, including:

- Cranes
- Road Graders
- Line Haul Tractors & Trailers
- End Dump & Side Dump Gravel Haul Trucks and Trailers
- Vacuum Trucks
- Mechanics & Service Trucks
- Light Plants & Generators
- Rollers & Compactors
- Crushing and Screening Plants
- Fuel Trucks & Tankage
- Spill & Emergency Response Vehicles
- Mobile Office Trailers

It is thought that much of this equipment would be potential for rail movement, such as Caterpillar equipment manufactured in Peoria, Illinois. Spare parts will also be significant and should be evaluated for inclusion as potential freight.

* Note: Information for entire Gasline Project.

Length, Alaska to Alberta: 2,140

Gas Conditioning Plant:

- 19 Modules (8,000 ton max.)
- Four Trains
- 56 acres
- Estimated Cost: $ 2.6 Billion
- Shares resources with Central Gas Facility

Pipe Design Basis (Alaska to Alberta):

- 52” Diameter
- 40’ lengths (to be double joined before installation)
- 2500 PSI

- X-80 or X-100 Carbon Steel
- Wall thickness 1.25”
- Buried Chilled Line

Pipe Design Basis (Alberta to Market):

- 52” Diameter
- 40’ lengths (to be double jointed before installation)
- 2000 PSI
- X-80 or X-100 Carbon Steel
- Wall Thickness .9” US & .8” Canada
- Buried Line

Sea – Lifts to Prudhoe West Dock: Four expected; Three for Gas Conditioning Plant, One for Pipe.

Construction Spreads: It is anticipated by the producers that work efforts in Alaska will be divided in three geographical sections or “spreads”. For the Canadian portion of the pipeline, six spreads are anticipated. It is anticipated that each contractor will be required to be self-sufficient providing their own equipment, supervision, facilities, consumables, etc. Owners will provide the long-lead time items such as pipe.

Construction Camps: Six temporary construction camps are anticipated to be utilized on the Alaska section of the project. These camps will be designed to be moved quickly and often to locations where needed. Two larger camps are anticipated to be placed near Galbraith Lake and Fairbanks which would remain in place during the entire construction period. No information on camps on the Canadian side are available at this time.

Pipe Rolling Facility: Much consideration is being given to placement of a Pipe Rolling Facility in Fairbanks. This would allow steel plate to be delivered to Fairbanks and fabricated into pipe for the project. This facility would also be able to bend pipe for the project. This has vast implications for the logistics of pipe movement both north and south of Fairbanks, as well as the ability for US Steel Mills to Participate. It is recognized by the producers that no steel mil in the world is capable at this time to produce 52” diameter 1.25” thick pipe. Also, there are no valve manufacturers at this time capable of producing 52” high pressure gas valves.

Take Off Points: Four in-state gas take-off points have been negotiated between the State of Alaska and the North Slope producers:

- Yukon River
- Fairbanks*
- Delta Junction
- Glennallen (if a spur is built to Valdez for an LNG Project)

Note: The Fairbanks take-off point adds the potential for a petrochemical complex in the Tanana Valley which would add significant construction activity aside from actual pipeline construction activities.

Freight to Support Producers Gas Development: There is not expected to be a great increase in tubular freight to the North Slope to support infrastructure development to deliver gas to the gas conditioning plant, as earlier thought. Currently 8 BCF of gas is handled per day at the Central Gas Facility in Prudhoe Bay operated by Conoco Phillips. Another 10 – 20 BCF per day is expected from Pt. Thomson. Further, the density of gas wells will be significantly less than that currently required for oil production. Each Prudhoe Bay gas well is expected to produce 100 million cubic feet of gas per day.

1.3.2 Future Oil Activity

The following outline and accompanying figures detail future viscous oil development on the North Slope. ***Figure 38*** from the Alaska Department of Revenue sets the tone with both historical and forecasted production rates for the Alaska North Slope, up to 2014.

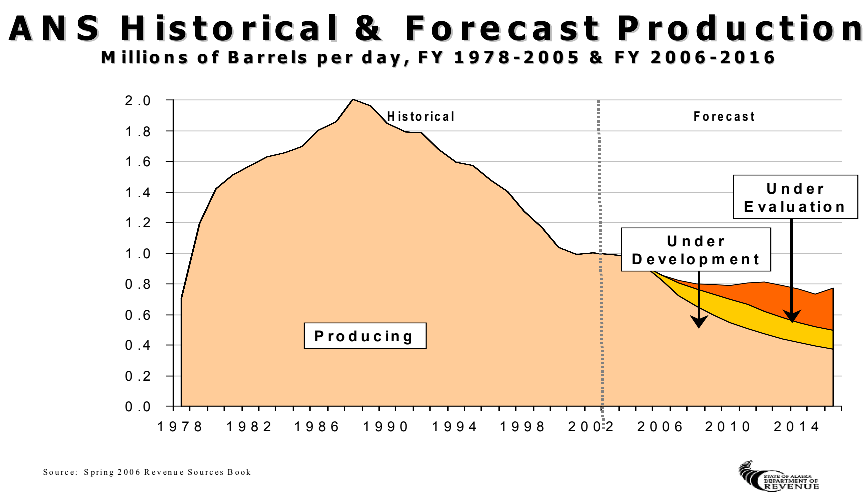


Figure 38: ANS Historical and Forecast Production

Figure 39 shows actual and projected North Slope production, 1969-2024, indicating a steady decline in the number of feet drilled per year. However, as detailed in earlier figures, drilling activity has generally had a close relationship to oil production. Prospectively, based on statements from producer representatives, drilling activity will increase substantially to maintain production near current levels. Heavy oil recovery could require several times the drilling activity that more traditional lighter crude recovery requires.

According the Department of Revenue's Chief Economist, since 1999 Alaska has tended to over-estimate production for two reasons:

- **Maturity of the Prudhoe Bay field** – The field has been producing oil for close to 30 years and is subject to problems associated with an aging field. Thus, leaks in pipelines – such as what occurred in early March 2006 – and other events are more likely to occur. To reflect this reality, the production rate for future years has been decreased at Prudhoe Bay.

- **Difficulties Developing "Heavy Oil"** – dealing with the viscous oil on Alaska's North Slope requires new techniques and technologies. Because of the issues dealing with viscous oil, many of the viscous oil projects have been delayed as the oil companies attempt to figure out the best way to deal with this gooey substance. To reflect reality, the speed with which the production from heavy oil comes on-line in the State's forecast has also been delayed.

For the spring 2006 forecast, the Department of Revenue has incorporated revised reservoir performance analysis on declining fields, reviewed the uncertainty associated with the pace and scope of developing satellite fields and re-evaluated unplanned downtime at all fields, especially Prudhoe Bay, resulting in a net reduction, on average, of about 30,000 barrels per day over the next five years. Roughly half of this reduction is attributed to reservoir performance and facility related downtime and half is related to the pace of development of heavy oil, primarily at West Sak.

As a Base Case, the forecast for ANS production is to average slightly above 800,000 barrels per day for FY 2007 through FY 2011.

North Slope crude oil production is characterized in three ways, each with discrete, albeit estimated confidence levels: (1) currently producing, (2) currently under development and (3) currently under evaluation. Each category provides for varying degrees of uncertainty associated with the production forecast. Production is only forecast for those reserves that have already been discovered and at minimum are being evaluated for development.

Oil production in Alaska is forecast to decline at a rate of about 6% in FY 2006 and about 1.5% per year thereafter. The forecast categories are:

- Production characterized as "currently **producing**" includes baseline production and presumes a continued level of expenditure sufficient to promote safe, environmentally sound operations. Such expenditures include the following: well diagnostic and remedial work, data acquisition and rate-enhancing expenditures such as perforating, acid stimulation, well work-overs, fracture treatments, artificial lift optimization and production profile optimization. This category of production also presumes continued gas and water injection for pressure support. Based on historical forecasting performance, we assign a 98% confidence level for the current fiscal year.

- Production characterized as "currently **under development**" is based on new projects currently funded and in the design/construction phase, as well as development drilling and enhanced oil recovery (miscible or immiscible injection) projects, currently funded or underway, but not included in the "currently producing" category. It also includes incremental oil expected from the long-term gas cap water injection project at Prudhoe Bay and the low salinity water-flood at Endicott. Examples of production "currently under development" include the Fiord and Nanuq satellites at Alpine, remaining J-Pad development at West Sak, development drilling at Schrader Bluff and certain satellite development at Prudhoe Bay. We have slowed the pace of development at all heavy oil fields to allow proper mitigation of challenging commercial and technical issues. Because of timing and scope uncertainty, our subjective confidence for this category of production is approximately 80-85%.

- Production characterized as "currently **under evaluation**" includes technically viable projects currently in the "pencil sharpening" stage where engineering, cost, risk and reward are all being actively evaluated. These projects are all currently unfunded by the operators but have a high chance of being brought to fruition. They include enhanced oil recovery at certain satellite fields, development drilling outside the core areas at West Sak and Schrader Bluff, expanded development at Prudhoe Bay satellites Orion, Polaris and Borealis and Alpine West development. Also included in this category is NPR-A development, Point Thomson, Liberty and development of other known onshore and offshore discoveries. Regarding NPR-A, we are forecasting production from four small 'puddles' in the vicinity of known discoveries currently named 'Lookout', 'Moose's Tooth', 'Spark' and 'Rendezvous'. Since these discoveries have been announced, there has been ongoing exploration outside the boundaries of these accumulations, and explorers continue to push further west in search of new development opportunities. Confidence levels vary for this category of production. Certain heavy oil development drilling for Schrader Bluff, Orion or West Sak in 2007 might have confidence levels approaching that of "production under development". Offshore developments such as Liberty, or potentially high cost, scope challenged developments such as Point Thomson probably deserve lower confidence, and our subjective assessment is in the 70%-75% range. All production from this category is subject to delays and scope changes that might impact reserves or production rates.

This Base Case anticipates Gas Pipeline construction beginning in 2011 or 2012, with an inservice date of 2016.

A variation on the Base Case, Viscous Oil, would involve substantially more drilling activity than the Base Case. The 'under evaluation' section of the Base Case would likely double with respect to drilling activity. Technology has not developed as quickly as once anticipated and the West Sak and Ugnu prospects have often been deferred in the forecast.

A second variation, ANWR/NPR-A/Foothills Development, would also represent an increase in drilling activity. Unlike the Viscous Oil case, ANWR is not a technological hurdle as much as it is a political hurdle. Once a gasline is actually sanctioned and development moves closer to Pt. Thomson, political pressure may very well increase to open ANWR's 1002 area for development. The NPR-A is currently forecast to see production on stream by 2011 with respect to Alpine West and the four prospects immediately west of Nuiqsut. Further western development would require both an oil transmission pipeline and production facility, plus a gas transmission line to the Prudhoe Bay area. The Foothills area currently has no development. It is distant from both pipelines and production facilities. The presence of a gas pipeline may bring further exploration into the Foothills, but that may not occur for another decade.

Finally, a third scenario may involve extensive offshore exploration and development. This is an item that is strongly opposed by residents of the North Slope Borough and is also very expensive and distant from infrastructure. The possibility is only mentioned for comparison. Each of the variations is highly capital intensive and will be driven by a combination of the long term fiscal regime, current oil and gas prices and the availability of resources (steel, drill rigs, labor) to undertake the projects.

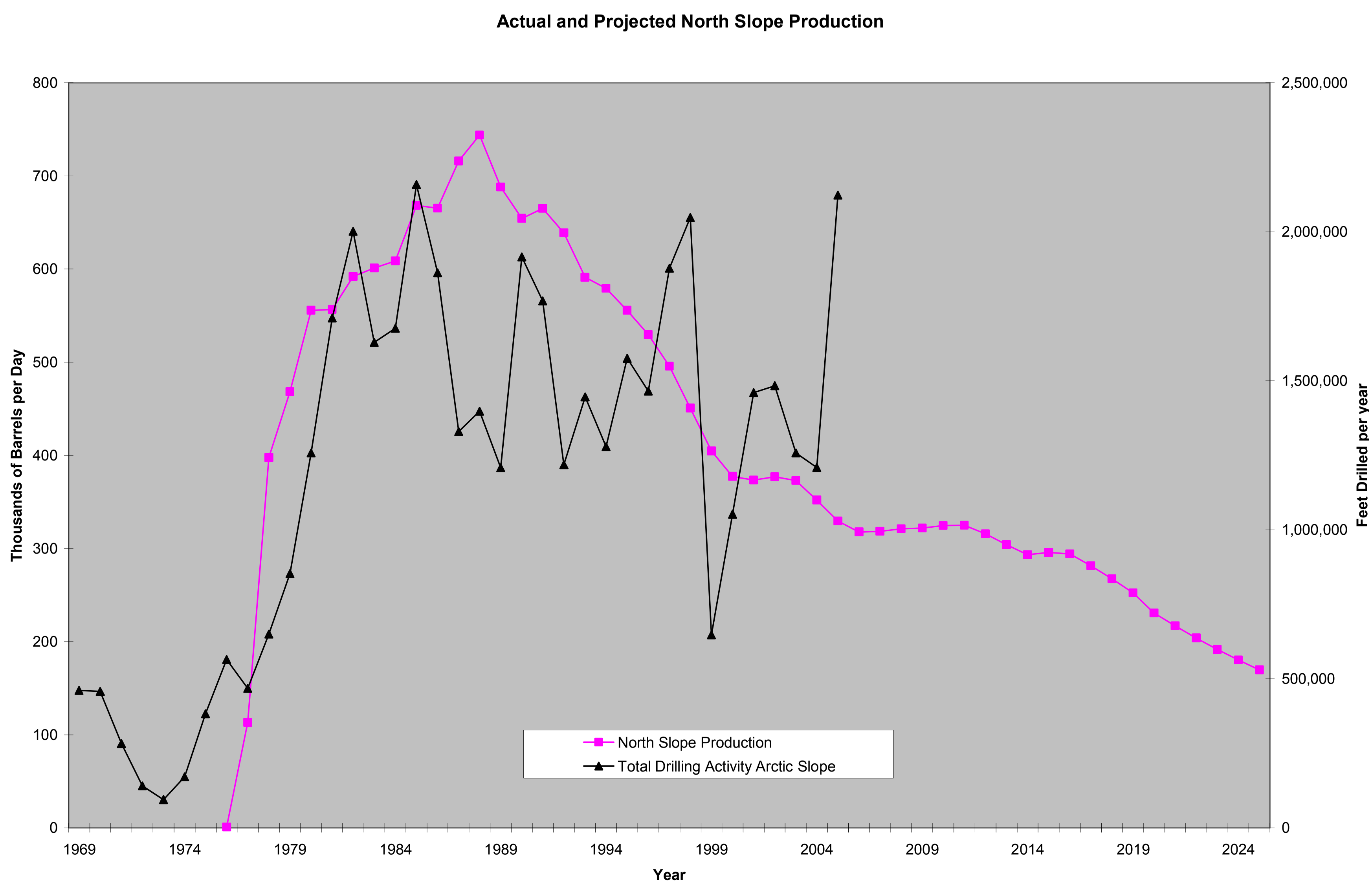


Figure 39: Actual and Projected North Slope Production

Background Discussion: Pilot work is being undertaken on the North Slope now by Conoco Phillips and BP to develop Viscous or "Heavy Oil" deposits at three main fields: West Sak Sands; Schrader Bluff and Ugnu. The first oil to be exploited will be the lighter of the crude to be found in these fields, that with 300 centipoises insitu viscosity, or less. It was identified by Conoco Phillips as the "biggest untapped resource in the North Slope oil fields", at an estimated 40 billion bbls proven reserve.

Schedule: The lightest of the high viscosity oil as described above will be produced from the West Sak field during the next ten years.

Cost: Estimated cost of developing West Sak & Ugnu: $ 30-$ 40 billion USD.

Effect on Rig Count/Tubulars/Chemicals: Conoco Phillips estimates that development of West Sak and Ugnu will double their current rig count to and double the resulting usage of tubulars and chemicals. It is under consideration by Phillips Conoco to convert a rig to be able to handle coil tubing for the heavy oil project. A water flood project is envisioned for the 2015-2016 timeframe to move into production of the heavier oil. It is unclear what happens to the drilling program at that point but it was indicated that additional chemicals such as warm lime will be required to produce "boiler quality" water for the flooding program. This water flood project will be similar to an effort being currently undertaken at the Surmount Project in Canada by BP. Clarification on the Schrader Bluff field impact by BP has been requested.

ANWR & NPRA

Project Location Challenges: Both ANWR and NPRA have great oil and gas potential. However, both are located significant distances from existing road infrastructure. NPRA would be the furthest east of any North Slope oil & gas development (with the exception of the Barrow gas fields). Conversely, ANWR would be the furthest east of any Alaskan North Slope oil & and gas development. Long distances from existing road access will drive how these projects are developed and supported. The most recent oilfield developments on the North Slope, such as Alpine, have been low impact in nature meaning no permanent gravel roads are in place to support either construction or operation and maintenance. Recent projects utilize ice roads for winter re-supply of commodities such as drill mud, tubulars and chemicals. Other commodities and transportation of workers is done by aircraft. Both ANWR and NPRA are both beyond what is considered to be practical for winter re-supply via ice roads. Two options exist to remedy this; construction of permanent gravel access roads and re-supply via sea-lift to new coastal docking facilities located closer to the developments than Prudhoe' east and west docks. This could negatively affect the ability to transfer support commodities via rail to Fairbanks and transship them via truck to Prudhoe and out to the respective developments, the commodities would be delivered via barge originating in the Gulf Coast or the Puget Sound area.

Note: It is expected that due to the distances from Prudhoe Bay docking facilities that construction of both ANWR and NPRA would require new docking facilities' nearer the *project sites for delivery of pre-constructed modules. Potential docking sites for ANWR have been identified in Camden Bay and west of the Aichilik River.*

ANWR: The edge of the ANWR 1002 area is separated from connection to existing Prudhoe Bay road infrastructure by approximately 50 miles. Construction of an access road connecting the service road to Bullen Point is currently being considered to support the Pt. Thomson project. The Point Thomson Unit and the ANWR 1002 area both share a common boundary line, the Canning River. Access to Bullen Point could be an effective take-off point for winter re-supply for ANWR via ice road.

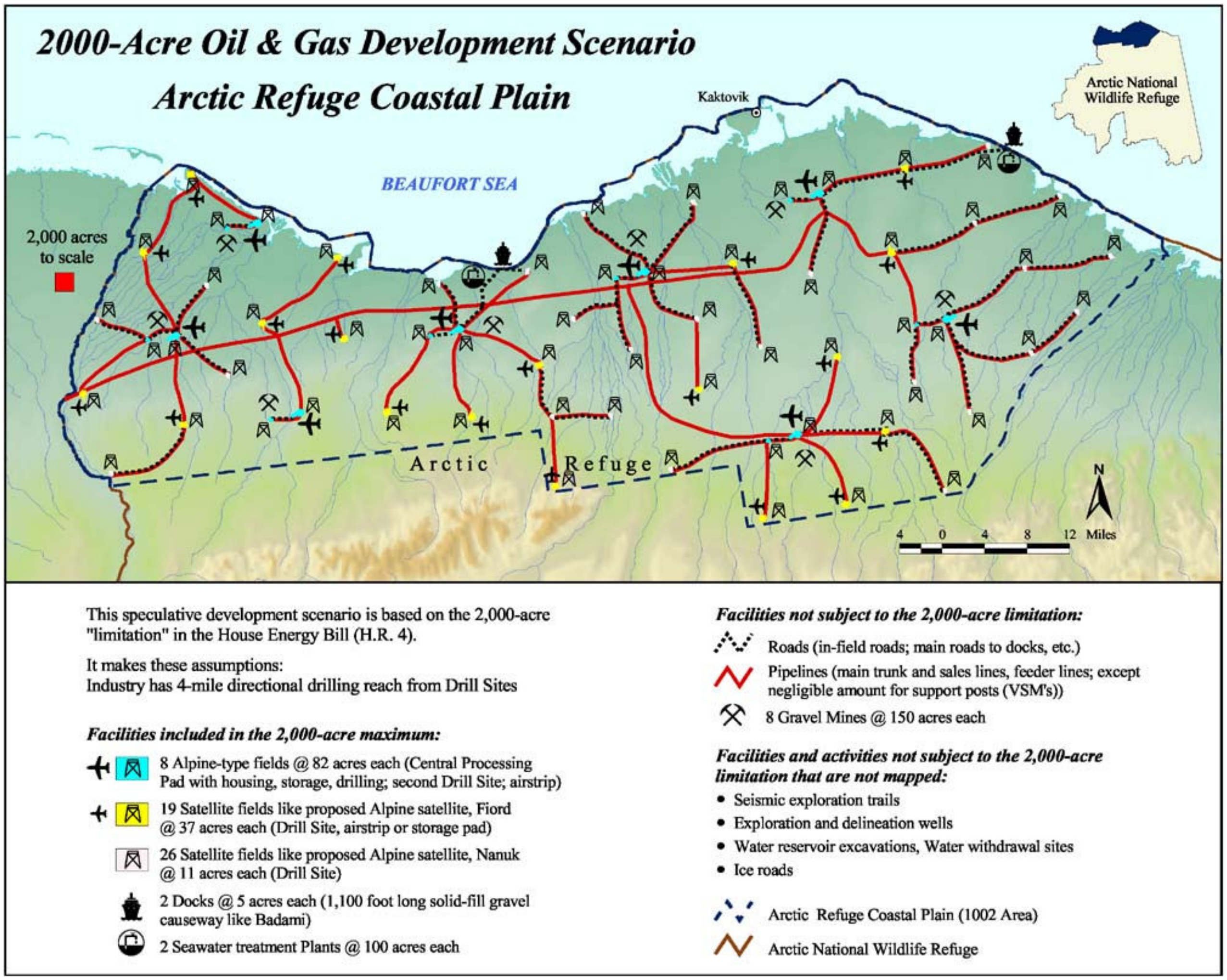


Figure 40: 2000-Acre Oil and Gas Development Scenario Arctic Refuge Coastal Plain[11]

ANWR Potential for Rail Link Freight: Development of ANWR is thought to be comparable to eight Alpine developments including associated satellite drilling and production pads. Compilation of tubulars and chemicals which have rail-link potential are being compiled by Information Insights and is expected to be complete by May 1.

[11] http://www.inforain.org/

NPRA: The eastern boundary of NPRA lies just to the west of the Alpine project. Early NPRA leases (1983), are currently being explored by smaller independents today. Re-supply for these efforts are accomplished similar to Alpine, utilizing winter access via ice roads. It should be noted however that FEX's Aklaq Project landed its materials at Lonely (abandoned DEW Line Station) via barge last fall for this winter seasons work. It is anticipated that the Lonely coastal access point may well become a staging area for NPRA exploration and production, including re-supply of tubulars and chemicals.

NPRA Potential for Rail Link Freight: NPRA has similar USGS estimates for amounts of recoverable oil & gas as ANWR, but the area of potential exploration is much greater. Ability to utilize rail-link freight for development of NPRA will depend on the success of two efforts; First, the completion of the Colville road linking the Village of Nuiqsut to either the Dalton Highway or the existing Prudhoe Bay Spine Road. And, second completion of the Niglik Channel Bridge.

As the operator of the Prudhoe Bay Unit, BP is currently undergoing a process to analyze the entire Prudhoe infrastructure to determine what improvements/upgrades are necessary to allow continued operation for the next 30-40 years. This freight is not recognized in the Gasline Construction tonnage. Also, it would be expected that BP will become more aggressive in their exploration program after Production Taxes and Gasline Agreements are finalized with the State of Alaska. ***Table 9*** details possible oil and gas development scenarios on the North Slope.

Development Scenarios	Oil Activity	Gas Activity
Base Case	• Current oil activity • NPRA production by 2010	• Gas pipeline production in 2025
Moderate Case	• Some heavy oil development • Increased NPRA production	• Gas pipeline production in 2020
High Case	• Increased heavy oil activity • Continued NPRA production • ANWR production in 2020	• Gas pipeline production in 2015

Table 9: Potential North Slope Development Scenarios

1.4 Conclusion

1.4.1 Assess the market for rail transport of oil and gas field supplies and equipment from the contiguous states and southern Canada to the North Slope of Alaska

In this chapter, the LMSO research team has identified current supply and demand for materials and equipment on the North Slope. If oil and gas activity on the North Slope continues at the same levels experienced today, some of the materials and equipment that are presently shipped to the North Slope via a combination of rail, barge and truck could be transported via an Alaska Canada rail link. More specifically, current shipments of chemicals and tubular could be shipped from their respective places of origin, decreasing the cost and inconvenience of shipping commodities via multiple transportation modes. Instead, those commodities that originate from Central and Eastern Canada and United States would travel the distance of the proposed Alaska Canada Rail Link, making only one transfer to truck in Fairbanks, Alaska, en route to Prudhoe bay on the North Slope.

1.4.2 Assess the market for the rail transport of a materials and equipment in support of the construction and operation and maintenance of the Alaska Natural Gas Pipeline

In terms of the use of rail transport to support future North Slope oil and gas activity, the LMSO team, with the assistance of major North Slope producers, has identified three most likely areas of development: the Alaska Gas Pipeline, Heavy Oil, and ANWR/NPRA development. Theoretically, each of these developments would warrant an increased demand for materials and equipment on the North Slope, and therefore a need to transport materials in the most efficient and economical means possible. As mentioned in Section 1.3, exact timelines and potential needs in terms of chemicals and tubular continue to evolve as project components take more shape. However, as noted by major producers in a series of personal interviews, all three developments require a delicate balance of considerations, economic, social and political.

1.4.3 Open Issues

As discussed in the introduction to this chapter, the LMSO research team confronted many challenges during the research process. In each section, data gaps and inconsistencies have been identified to give the reader the entire picture of the research process and the data presented.

Chapter 2.0: Synergistic Values of Natural Gas Pipeline and Rail Link Co-Development

2.1 Introduction

In Alaska, prosperity is never accidental; the overlapping realities of wilderness expanses, tectonic interactions, and climatic variations present a harsh contrast of constant peril and boundless opportunity. Wide open spaces of the world's most pristine landscape present both a formidable logistics challenge and a globally renowned opportunity to experience natural landscapes devoid of human interference. Aside from threatening ports and cities with earthquakes, active plate boundaries endow Alaskan land with considerable natural resources and a perfect laboratory for studying the foundations of Earth's dynamic surface. Climatic interactions contrast survival risk with the chance to develop civilian and military solutions in some of the world's most challenging environments without leaving American soil.

Survival and leveraging Alaska's matchless potential have always required endurance, ingenuity, and most of all, planning. Alaska natives, Russian explorers, American pioneers, and pervious generations of Alaskans from around the world have left a legacy of success through working with nature to thrive in a most difficult environment. Autonomous village communities, the Trans Alaska pipeline, and arctic fishery markets are a few examples of the past miracles of Alaskan ingenuity.

Commonly controversial and never without risk, Alaskans have shown that haphazard attempts to live in the arctic by force is futile, while well planned self-reinforcing initiatives can produce an unmatched quality of life. By recognizing opportunity, patiently waiting for natural and market forces to align, and through rigorous analysis of synergistic effects, Alaskans have integrated their own enterprises into the natural progression of life.

Taken individually, most of Alaska's landmark decisions, its purchase notwithstanding, appear to have been risk ridden and even impulsive. An accurate assessment, however, requires an understanding of the full context including the environment, existing resources, and the enterprising nature of its residents. Developing economic structures from an interrelated system of overlapping resources requires the examination of forthcoming opportunities in light of each other and the anticipated long-term market environment.

The best way to provide for Alaska's future is to foster the ad-hoc configuration of shared resources into innovative solutions. A distributed network of interacting industry creation efforts will enable developers to thrive support each other across the diverse Alaskan landscape. Providing Alaskan's with redundant and widespread infrastructure components is the only way to grant the flexibility and toolsets needed to explore and interact with their unique environment. Two of the most noticeably absent resources in interior Alaska are reliable transportation and cost effective power.

As previously demonstrated within this report, expanding Alaska's infrastructure through the development of an enhanced rail system would present the potential for considerable value as a stand-alone venture; expanding rail service in conjunction with North Slope natural gas development, however, would ultimately provide the cost effective transportation and energy solutions necessary for Alaska to finally take advantage of her rich stores of natural resources. Below is a discussion of the values natural gas development would offer to ancillary industries and how these values would combine with the proposed rail extension to dramatically enhance Alaska's economic outlook.

2.2 Gas Enhancement of Industrial Development

Terrestrial transportation challenges and limited tidewater access make Alaskan resource extraction efforts among the most expensive in the world. In order for Alaskan commodities to compete in the global marketplace, they must either have access to inexpensive energy and transportation, or they must be processed into value-added products that can better justify the requisite investments in transportation.

A. ***Scalable Energy:*** The potential for gas line pressurization points to be used as power generation or spur pipe draw points could provide scalable energy capacity to smaller industrial and community applications along the gas line corridor. The scalability and lower requisite capital investment of natural gas power / heat facilities would also permit smaller communities to invest in redundant or expanded power supply solutions.

As one of the simplest resources to convert to energy, small scale gas turbines would allow electrical generation efforts to be undertaken incrementally as demand grows and thereby limit installation risk and increase the overall solution's flexibility. Portability and heat production capabilities could couple well with rail service to offer resource exploration businesses the ability to investigate a variety of potential sites and develop the most promising locations before progressively expanding or moving their energy production investments to lower profit deposits as the economies of scale distribute operational costs.

Examples of Scalable Energy Dependant Opportunities:

a. Community power redundancy
b. Wildlife management technologies
c. Climatic and Natural Science research
d. Timber value development
e. Local ore and industrial materials processing

B. ***Complex Hydrocarbons:*** Large scale development of North Slope natural gas resources would not only produce a high value energy source for sale to the Mid-West, but it would also offer the ability to extract and market the more complex liquid components of the gas. These petrochemical building blocks are far more valuable as base components of many manufacturing products such as ethylene glycol and Styrofoam than they are as sources of energy. By providing the infrastructure to extract and utilize these hydrocarbons, natural gas development would offer the following potential ancillary values to the Alaskan economy:

a. *New industry development \ investment* – one option for taking advantage of these materials would be to develop them into value-added products within Alaska. Doing so would require the building of a large scale petrochemical processing plant somewhere in the state and would bring with it an influx of investment, expertise, and support industry expansion.

b. *R&D opportunities* – the desire to minimize the economic impact of transportation costs on the petrochemical exports would likely spur investment in research and development around maximizing the value-added product marketability while minimizing processing costs. These investigations would open up a world of opportunity for local research into novel sources of: high value materials, processing efficiencies, transportation effectiveness, and factory \ process design.

c. *Increased transportation demands for materials* – petrochemical industry development will require expanded transportation systems to supply equipment and supplies while expeditiously transmitting final product to global markets. These increased shipping demands will help to develop economies of scale that lower related business shipping costs, and will also help to amortize the costs of developing expanded rail services.

d. *High value exports on trade balance* – by taking the maximum advantage of Alaskan resources and populations, the development of a new industry around the processing of complex hydrocarbons would improve the Alaskan and American balances of trade in the global economy. Much of the anticipated market for these petroleum based materials will be coming from Asia for the foreseeable future, yet even if the products end up in domestic markets, there will still be the advantage of less international markup and less product imported from overseas.

C. ***Economies of Scale:*** Transportation and distributed energy production economies of scale have been presented above, but building a system with as much economic potential and geographic breadth as a natural gas processing will certainly increase the scales and thereby efficiencies of many related products and services as well.

a. Extended utilization of railroad and ore development construction material sites will lower the cost of development for each effort.
b. Adding value to existing highway and rail corridors will extend the usefulness and scale of existing remote sensing and geographic investigation datasets.

c. Common communication and labor requirements will certainly lower overall costs and risks of developing these two critical resources.
d. Lastly, the potential for an Alaskan based petrochemical plant would require vastly more power than is currently available, and therefore would provide a much needed boost in power production effectiveness and scale.

2.3 Gas \ Rail Synergistic Applications

The aforementioned gas development effects on Alaska represent only a fraction of the infrastructure upgrades necessary for globally competitive industries. For most of the opportunities empowered by gas development to come to fruition, they will require not only the energy and materials provided by natural gas, but also the reliable high volume transportation provided by a transcontinental railroad system. In fact, even the effective development of the referenced gas pipeline and infrastructure would be difficult without a co-investment in a railroad extension to the Mid-Western United States.

In order to understand the likely impact of either an investment in rail extension or a North Slope natural gas pipeline, one must examine the interplay of their values in concert. Below is an overview of industrial applications that would be enhanced or enabled by the low cost energy, transportation, and ancillary benefits of coordinated natural gas and railroad developments.

Value-added Ore Extraction: Current Alaskan metallic ore extraction models call for the sale and shipment of ore concentrate materials rather than consumable metals. Due to the lack of smelting facilities in North America, most mining operations must sell the ore concentrate to overseas firms that proceed to separate the valued material from containing rock and distribute the refined metals on the global market. This process is an inefficient method of extracting value from Alaskan natural resources for many reasons.

First of all, the transportation costs for moving ore concentrate are dramatically higher than for moving the target metal due to as much as 2/3 of the transported weight being made up of worthless rock material. Additionally, the transfer to foreign firms adds extra steps to market, and thereby increases the final price to domestic consumers and negatively affects the balance of trade between the United States and Asian markets. Lastly, the sale of lower value ore concentrates cheats Alaskan stakeholders out of the true market value of their heritage.

If Alaska's metallic resource managers could gain access to low cost power supplies and transportation systems throughout the state, it would be possible to move away from the traditionally centralized smelting process to a distributed refinement solution known as electro-winning. The electro-winning solution is a single stage refinement process that is simplified by the presence of large amounts of electricity as an alternative to the progressive melting and extracting stages of an overseas smelter.

By taking advantage of the access provided by rail extension and the low cost modular power of a natural gas pipeline, Alaskan mining operations will be able to cut transportation weight by 2/3, decrease the transportation cost to value ratio, increase the efficiency of metals industries, and improve the international balance of trade between American manufacturers and foreign extraction industries.

State-wide Energy Cost Reductions: For a state so rich in natural resources, Alaska pays amazingly much for its energy. A driving force in this high cost of power is the limited power requirements for running the state. Low population densities, limited industrial development, and vast undeveloped expanses limit effective investments in high volume production systems. Subsequently, Alaska's power requirements must be fulfilled by less efficient, but lower capital requirement, sources of electricity. Most communities rely on natural gas or diesel for primary and backup power generation.

The most effective way to decrease per-unit energy costs is to increase the overall demand for the product to a level where investment in large scale, coal fired power plants is warranted. Historical precedent is evident in the energy cost impacts of the Fort Knox mine development on the Fairbanks North Star Borough. A study completed in 1999 concluded that, the additional power volumes required by the mine lowered residential power costs by 7% and large commercial power rates by as much as 10%[12]. The anticipated power requirements of a petrochemical plant alone would warrant the development of a 400 + megawatt power plant and the accompanying reductions in power costs.

It is anticipated that the additional industrial development options presented by rail extension and gas line development would generate a self-reinforcing downward pressure on Alaskan energy costs. Petrochemical and mining operations would all require additional low cost power sources; the more initiatives that come on line, the better the economies of scale become, and the more operations that can afford to come on line. The key to beginning the process will be to provide low cost transportation in concert with the modular power and high value petrochemical prospects of a well-developed natural gas infrastructure.

Immediate beneficiaries of an expanded power generation demand would include current mining operation in need of competitive power such as the Pebble and Donlin mining developments. Communities across Alaska would benefit from the increased redundancy and capacity provided by expanded infrastructure, as most lack an effective emergency or backup power solution. South Central Alaska will likely be progressively more dependent on any large scale power developments as the natural gas fields in the Cook Inlet become less productive and subsequently more expensive to operate.

Petrochemical Development: The so-called 'wet gas' that may be extracted from the North Slope gas fields contains a substantial concentration of high value complex hydrocarbons that can be processed into a wide variety of chemicals and materials critical to manufacturing industries. Taking advantage of these molecules would require delivery of the gas liquids to a petrochemical complex with substantial electrical, thermal, and water resources readily available. While these complexes already operate in Canada as

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[12] Economic Impact of the Fort Knox Mine on the Fairbanks North Star Borough (page 16)

well as along the Gulf Coast, drawing the liquids off prior to shipment of the gas across the continent would cut down on the pipeline design requirements while providing a substantial industrial development opportunity for Alaska.

If Alaska were to build her own petrochemical complex, there are two viable sites for converting the gas liquids to saleable petrochemical products. The first solution would be to build a pipeline for the raw materials from Fairbanks to Point MacKenzie where one could build processing and expanded port facilities for shipping overseas. Of the two locations, Point MacKenzie would probably offer the lowest overall transportation costs; these lower transportation costs, however, come at the expense of the security afforded by placing such a valuable complex out of the highly seismic South Central region of Alaska. If the complex could be competitively operated out of the interior of the state, it would be far more effective at diversifying and stabilizing the economy while remaining safely out of the way of most 100 year seismic probabilities.

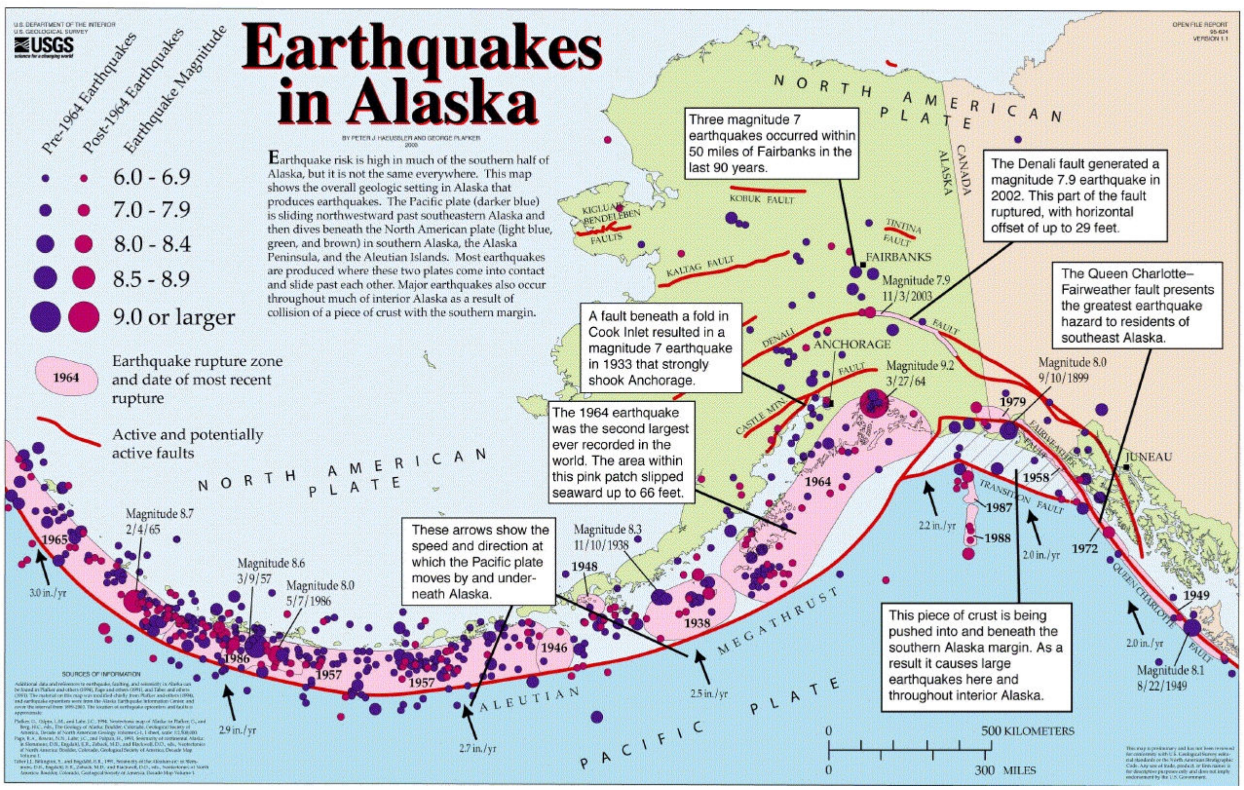

Figure 41: Fault and Earthquakes Locations Map

The second and more secure option for placement of a petrochemical complex would be outside of Fairbanks. Taking advantage of the proximity of the existing North Pole refinery, this location would negate the need for an additional pipeline to Point MacKenzie and would limit the distances over which refinement based chemical inputs would need to be transported. In addition to base gas liquids, the three major requirements of petrochemical processing are fresh water, benzene, and low cost thermal / electrical energy. North Pole has ready access to fresh water via the Tanana River; the

North Pole refinery could provide adequate benzene; increased rail transport of Usibelli coal would provide an economical source of heat and electricity.

The two additional industrial capacities necessary for placement and operation of such a plant in Northern Alaska will be a ready supply of gas liquids and a low cost, secure method of conveying the products to market. By building a gas pipeline through Canada, resource managers would provide a primary market for the gas itself, and would thereby make extraction of the liquids economically feasible. The potential for rail service directly into the heartland of American manufacturing would offer a competitive transportation solution for carrying the value-added products to a primary market.

Metal Mineral Location Access: Better than 20% of the operating expenses for the Fort Knox mine go toward the purchase of electricity[13]. Large amounts of heat, power, transportation support, and geologic information are necessary to operate a profitable mineral extraction business. At this point, none of these resources are available to the majority of the reported mineral deposit locations throughout Alaska. Along the 100 kilometer wide proposed railroad extension corridor, there are approximately XXX potential sites for mineral exploration and development. While rail extension alone would lower supply and product transportation costs to this corridor, efficient extraction of these resources will also depend on the heat, power, geologic, and communication development efforts likely to take place as part of a natural gas pipeline construction project.

By permitting the development of low cost power and heat infrastructures, delivery of BTU laden gas near the mineral sites would greatly reduce the operational overhead of the developments. Communication infrastructures put into place to support the construction and maintenance of the pipeline and rail line could provide critical mine management tools. Lastly, the geologic research that would take place along the corridor for both track leveling and underground pipeline protection could dramatically lower the discovery and planning costs traditionally associated with remote resources development.

Together, these risk and cost reductions from routing power and transportation across Eastern Alaska would permit the exploration and development of previously inaccessible resources. Most likely, they would also support the extraction of those resources that would previously have been too small to warrant investment. Enabling smaller operations to compete on global markets would be a boon to Alaska’s interior communities while stabilizing the state’s notoriously volatile economy.

As an existing Alaskan mine model, employees of the Fort Knox mine earned 70% more in salary than the Fairbanks North Star Borough average. As an ancillary benefit, the operation enabled the employment 1.2 support personnel for each direct employee of the mine itself. In some situations, total economic impact of mining operations have been seen as high as the value of the ore itself (ref) XXX. In this particular corridor, that value has been conservatively estimated at about $XXX.

[13] Economic Impact of the Fort Knox Mine on the Fairbanks North Star Borough (Page 7)

Industrial Materials Development: Alaska has long been overlooked as a major source of heavy industrial materials on the global market. Current access and energy cost limitations prevent the competitive development of low value, high volume product exports; the creation of an expanded power grid and simplified transit system could enable large and small scale development of industrial material economies. While Alaska's varied landscape offers many opportunities for industrial development, two currently high demand products offer the greatest short and mid term potential.

Limestone is a primary ingredient in portland cement and is readily available in Alaska. Currently, the lack of an economical transport prevents its effective extraction. Taking advantage of a possible Dunbar to Livengood rail extension would provide a route from the Limestone quarry sites to the Yukon River where barges would carry the materials to tidewater. Currently, and for the foreseeable future, China's booming construction industry is drawing substantial portions of the global lime market and thereby driving up material values. If Alaska were able to economically extract and ship the lime to Midwest markets directly, it could offer considerable value to both rail operations and the Alaskan economy.

Dimensional stone is another potential industry for development in Alaska. Eastern cultures value cut stone as a facing material in commercial and home construction projects. In addition to supplying this ready market, dimensional stone offers the unique benefit that it may be developed progressively. Low costs of entry would enable it to begin via small cottage industry style commercialization. Markets in Alaska, the United States, and overseas could be consumers of Alaskan milled stones in small tiles as well as larger slabs. An economical transport method, along side sizeable power scale economies, would enable localized investments in stone processing and the competitive development of these products.

Industrial Risk Reduction: Current transportation and energy production economies dictate that any large scale economic development undertaken in Alaska must take place in the highly populated and seismically active South Central region of the state. By requiring that industrial complexes and material processing be located at the tidewater access points in Anchorage or Valdez, Alaska places its populations, single mass export mode, and highest value land in the same seismic bowl with its primary economic forces. An alternative extra-state transit system and a distributed power solution would not only lower risk by way of redundancy, but also by permitting industrial development in the comparably safe interior regions.

Emergency Response Effectiveness: Community development opportunities resulting from cohesive rail and gas development are not limited to transportation and energy. In addition to the direct services rendered by the industries, their respective investments in project support infrastructure may be of great long-term value to Alaska. Already mentioned are the benefits of increased access, redundancy and electrical efficiencies; indirect benefits arise from investment in environmental sensors, geologic composition information, communication systems, and redundant commodity supply routes that could be of great value in emergency response and mitigation efforts.

Climate and ground condition information will be critical to gas as well as rail, both during the design \ building phase, and during the long-term operational phases. Throughout the initial design and construction processes, the gas pipeline project will require an extensive assessment of permafrost conditions, fault locations, floodplain ranges, and any geologic conditions that might result in abnormal settling of the line. Building the railroad corridor will involve a great deal of terrain and slope analysis in the effort to keep excavation and construction costs to a minimum. Bridge crossings and adequately gentle slope approach design will be difficult engineering challenges that require enormous amounts of mapping and surface condition information.

Between these two major discovery experiences, the State of Alaska has the potential to amass much of the mission critical situational awareness context that would serve as a basemap for emergency response efforts in Eastern Alaska. Data integration efforts around fault discovery, watershed mapping, and remote sensing interpretation would all help to advance the value of existing State of Alaska mapping initiatives. Additionally, the projects' data processing scale, standards and resource management solutions could provide the State with considerable leverage in procuring similar datasets for the rest of Alaska.

Once the projects become operational, even more emergency response and land management tools could become available to community and State stakeholders. The Alaska Railroad is transitioning to positive train control, while pipeline safety will certainly require embedded sensor arrays to detect environmental or functional anomalies that might hinder the safe operation of the line. The communication and positioning technologies required for positive train control would couple well with the pipeline feedback systems to offer remote communities an unprecedented level of understanding about their surroundings.

Impact on Rail and Gas Economics: To this point, the discussion has examined the novel industrial development impacts of gas \ rail co-development on communities and economies around the state. The benefits of the synergy, however, would not be unilateral. Many aspects of both the rail and pipeline will benefit from their complimentary creation and the resultant development of emergent industries. An overview of potential economic enhancements follows:

a. Construction Material Site Amortization: Any construction project, be it pipeline, rail, mining, timber, etc. will be able to take advantage of the material site discovery and development efforts in support of the other projects.
b. Increased Energy Market: Energy production capacity generated to power pressurization stations could be re-sold to local power consumers or to the Alaska Railroad for track feedback and maintenance solutions.
c. Communication Investment Amortization: pressure station operations, pipe status feedback, railroad maintenance logistics, positive train control, corridor communities, and new industries are all potential consumers of

communication services; their collective scale will offset the investment costs of whichever project makes the infrastructure investment, and they will certainly lower the overall cost of service due to their shared needs.

d. Expanded Freight Markets: Lastly, all of the aforementioned novel economic and community development potentials will reinforce the value of the railroad by increasing the freight traffic, and potentially, the per volume value of the goods carried; as such, the concepts developed above form a self-reinforcing economy that will likely be exponential in its aggregate return rather than another example of existing linear growth models.

Economic Stability: Alaska's economic health is more than the net value of its resources. While all of the opportunities above will profit Alaskans and the businesses that operate within the state, their cumulative affect on the state far exceeds the current market values of the resources to be developed. Long-term trends in commodity prices, foreseeable evolutions in the global economy, and the current homogeneity within Alaska's economic prospects all point to generous economic returns on extraction investments in Alaska over the coming 15 to 20 years. Here are a few of the non-commodity economic benefits of effective energy and transit solutions in Alaska:

- *Balance of trade improvement:* Raw natural resource exports are the least effective way to improve a society's balance of trade. Historical economic models for Alaska have necessarily focused on extracting natural resources and shipping them off-shore for processing. They are then either re-imported or sold overseas. This model restricts Alaska's benefit from her resources to the notably volatile prices of raw commodities (minus excess transportation costs) while permitting external agencies to reap the far greater markup potentials of value-added production.

  In this way, America takes economic hits both coming and going. Upon export, the inflow of cash is limited by the loss of value-added export opportunities; re-importing the products, Americans end up sending more cash off-shore for foreign processing, taxes, and bi-directional transportation costs. By producing domestic and foreign market supplies out of Alaska's own natural resources, the net global cost would be cut by the removal of transportation and supply chain depth, and the local balance of trade for derived products would transition from negative to positive.

- *Dollar value & commodity price trends:* Most analysts agree that the age of Asian markets is upon us. American dollars can only be propped up for so long by gulf state and People's Bank of China investments in treasury bonds. American dollars have steadily lost value against their Canadian counterpart since 2002 and will likely reach parity within the next 12-18 months. Such devaluation, even on a small scale will have a direct affect on America's ability to procure low cost industrial inputs from the East. At the same time, the global comparative value of Alaska's commodities will rise.

As long as China and India continue their march to industrialization, material commodity values will continue to rise with the demand. With the matching devaluation of the dollar, Alaskan exports will almost certainly become more desirable on the global market. If Alaska can leverage high value-added processing techniques to maximize the export value and minimize the per-unit transportation costs, Alaskan natural resource development could quickly become a significant factor in the upcoming Asian economic revolutions.

- *Extraction technology development:* Few economic prospects offer greater long-term return than the promise of improved educational and technology development resources. If Alaska takes advantage of the joint rail and gas opportunities, such as value-added resource extraction and petrochemical development, there will surely be an influx of research and educational funds and expertise. Alaska presents a unique landscape of research possibilities due to its remote nature and untapped capacities. As such, it is a perfect proving ground and logical intellectual center for long-term global extraction and processing technologies. The prospect of these two projects finally catalyzing joint educational and commercial technology centers in Alaska warrants an entire economic study of its own.

2.4 Conclusion

Freight traffic volumes and net gas profits are only the tip of the economic iceberg that is cooperative rail \ gas line development. Mineral extraction efficiencies, community development opportunities, and production scale values are difficult to predict but undeniable in their affects on Alaska's long-term economic development. Because gas development infrastructure and cross-continental rail capacity would provide Alaska with two of its most critical assets, their cooperative development will finally allow the state to take advantage of its matchless bounty of natural resources. With the anticipated transportation and energy capacities in place, Alaskan ingenuity will certainly see the development of a responsibly managed extraction and processing future for the state.

Inevitable resource crunches and clear commodity market trends should allay any fears that a rail belt extraction industry will fail to materialize. In all likelihood, many of the material extraction opportunities around the state will be exploited regardless of rail and gas efforts, but they will take place at enormous economic and environmental cost to Alaska. Without the coordinated planning and analysis that accompanies the development of centralized transport solutions, individual resource site developers will design solutions around their own select requirements.

Such a sporadic development model would not only be terribly inefficient in terms of Alaska's landscape and resources, but it would also deprive each and every Alaskan of the value stemming from increased production scale. Such a development model would also price most Alaskan developers and communities out of the market and leave the real profits for outside firms that can afford the capital and to absorb the waste that results from stand-alone mineral extraction operations. Alaska's resources will be extracted in one way or another; current decisions will determine how much of that value stays at home.

Chapter 3.0: Reduced Market Risks Due to Multiple Transportation Options

3.1 Introduction

Far reaching geographic bounds, sparsely arranged population centers, isolated communication \ power solutions, and generally harsh environmental conditions place Alaska's various communities at great risk when faced with the loss of a single transportation corridor. No community or population center within the state is immune to isolation from critical resources in the case of an environmental or infrastructure accident. Almost every congregation of people within Alaska is subject to a single point of failure with respect to one or more resources necessary for sustaining their health and well-being.

Anchorage's reliance on North Pole fuel production, food supplies from West Coast ports, and communication via sub-marine fiber connections place Alaska's largest population center at the mercy of roads crossing major faults, high risk port capacities, and a single major communication link. Fairbanks and North Slope communities rely upon steady deliveries of basic commodities and materials from Anchorage and the Lower 48. South Central Alaskan towns and villages rarely have redundant power supplies and generally rely upon a single road or marine transportation mode for supply deliveries. Lastly, and most susceptibly, the many population centers scattered across the Eastern, Central, and Bearing Sea regions of the state are held together by the most tenuous of communication, transportation, and economic threads.

While Alaskan's have shown an amazing level of self-sufficiency and ingenuity when facing economic or physical hardship, the land's harsh environmental and geographic conditions dictate that disaster recovery requires extensive support from neighboring communities and possibly even help from the rest of the nation. This portion of the Alaska Canada Rail Link Analysis is intended to review some of the most probable sources of community isolation and how expanded rail service might help to mitigate potential damage brought about by a transportation disruption within Alaska. To that end, this chapter will examine the state's primary transportation solutions, the risks that may befall them, and a sampling of the risk aversion opportunities that would stem from a rail line connecting Central, Eastern, and South East Alaskan communities with the rest of the state and the Lower 48 states.

3.2 Critical Transports

When studying the effects of transportations systems on a community's ability to develop, there are three primary forms of transit that must be taken into account. First and foremost, any community that is not entirely self sustaining must have a solution for commodity supply that provides the steady stream of perishables necessary for human sustenance. In many areas of Alaska, uninterrupted commodity transport is a matter of survival, even for short periods of time. Inadequate space or infrastructure for long-term storage of medical and food supplies frequently prevents Alaska's more remote areas from existing very long without external supplies of their basic needs.

Critical Transport Types		
Commodities	***Materials***	***Communication***
Food	Industrial Supplies	Equipment Monitoring
Electricity	Construction Equipment	Project Coordination
Water	Fuels & Chemical Products	Personal Contact
Medical Service Support	Building Materials	Sensor Feedback

Secondly, in order for a community to expand or maintain its infrastructure and economy, there must be a method for reliably importing and exporting industrial materials. These materials may be related to construction, conversion, or resource development, but regardless of their application, these materials will have more bulk and less urgency than commodities. Lastly, for the effective management of a modern community, there must be a reasonably accessible and extremely reliable method of continuously communicating with the community's supporting populations.

Alaska has a relatively simple network for large scale transport of all three types of supplies. The following is an examination of the principal nodes and links that make up the network. By examining the various network components, their primary purposes, and the risks associated with each, the stage will be set for reviewing Alaska's supply transportation needs and how an extended rail solution would mitigate the risks associated with existing network component failures. Additionally, this network based analysis will permit future research to examine the observations herein alongside anticipated capacity and economics models to numerically bound the impact of current risk and future opportunity.

3.3 Transportation Node Risks

Transportation Nodes: Transportation nodes are the intersection points between multiple transportation routes and modes. By establishing decision points and the opportunity to transfer between one transportation mode and another, nodes experience the greatest risk of economic, industrial, or environmental disruption. If a single node is disabled or poorly planned, the resulting effects will have an impact not only on the surrounding populaces, but also on those populations and environmental elements served by any of the links passing through the node.

3.3.1 South Central Ports -

The ports of Anchorage, Seward, Whittier and Valdez all serve as deep water access points for personnel, industrial, and commodity transfers from oceanic shipping to community supply and terrestrial transport. Container, equipment, and bulk materials all enter and leave Alaska through these primary connection points due to the high volume international efficiencies currently only possible via ocean transport.

Primary Transport / Purpose: Petroleum derivatives, wood products, building materials, and consumer goods all take advantage of these high volume port facilities on their way into, or out of, Alaska. As the most cost effective method for large scale transportation beyond the state's bounds, these facilities permit the transport of military equipment, oversize machinery, and non-perishable commodities into Alaska and the export of high-volume natural resources to national and international markets.

Principal Risks: Seismic activity, with the accompanying potential for wave action, probably forms the greatest risk to these high-volume, slow-repair facilities. Fast currents, complicated navigation requirements, and the criticality of the surrounding marine environments all increase the threat of widespread environmental impact from even a minor operational mistake.

Additionally, questions about the long-term ability of existing facilities to respond to growing global freight requirement may present considerable economic risk to the state. Permitting difficulties, silting / erosion complications, and the ongoing risk of sea ice all limit the reliability and expandability of deep water ports in Alaska. Taken together, the potential for infrastructure damage, the difficulty in avoiding environmental impact, and the inherent constraints of sea transport promise that exclusive reliance on these facilities for military, equipment, and bulk transport will always threaten the stability of Alaska's transportation network.

Infrastructure, environmental, and economic risks are all exacerbated at these critical transportation nodes due to the difficulty in securing a port facility. Unregistered closed containers, misrepresented port-of-call documentation, and the necessarily open design of port facilities all confound efforts to limit access and risk of attack. The geographic criticality of Alaska to international freight conveyance makes the state's marine facilities particularly inviting to foreign or domestic hostility. While modern ship and container tracking technologies may slowly mitigate the security risk to these transportation nodes, the importance of these facilities to the effectiveness of the other network components dictates that dependence on ports as a sole mode of high volume extra-state transportation places Alaskans at risk.

Rail Mitigation: A single seismic event or a rail disruption in Anchorage could render all of these port facilities inoperable. Because all of the South Central ports send their traffic through Anchorage on the way north, while sharing a common risk of fault disruption, they collectively represent a single point of failure for large scale product delivery into, or out of, Alaska. In the event of a seaway crippling incident, the ability to supply the materials and manpower to rebuild the operations would be severely hampered. The development of a land based route to Southeast port facilities and to other North American supply markets would create a redundant solution for brining heavy equipment and materials into the state to support emergency response and industrial repairs. This complementary method of transferring materials from sea to land could also keep the rest of the state in operation while repairs take place without overwhelming the limited road infrastructure.

3.3.2 South East Ports –

Skagway, Juneau, Sitka, and many other community harbors are all smaller port facilities that serve a combination of industrial, commodity, and human transport functions. Representing the nodes of the Alaska Marine Ferry System, these ports are the sole non-aviation method of product import and export for the region. As nodes serving the greater Alaskan and American economies, however, these communities have limited capacity and could serve in only an emergency situation as fuel stop or staging areas for localized rebuild efforts.

Primary Transport / Purpose: Due to difficult marine and aviary navigational conditions and limited interaction between the ports, current leverage of these port resources is primarily limited a combination of local commodity import and the export of locally extracted raw and value added products. Timber, tourism, and high value fisheries present the principal resource development initiatives and subsequently demands for transportation services. Due to high energy costs, limited developable land, and community isolation borne of island landscapes, it is unlikely that these nodes will serve more global roles without the addition of some other transportation infrastructure solution.

Principal Risks: While not as seismically endangered as Central and Western Alaskan ports, these South East communities may be at greater isolation risk due to their complete reliance on marine transport for all elements of their economic development. Inclement weather and difficult navigational conditions limit the reliability and cost effectiveness of airborne supplies, so environmental, industrial, and malicious disruptions of harbor or freight transfer facilities could cut off economic and safety supplies for considerable periods of time.

Without any backup form of transport for industrial supplies, rebuilding effort difficulties would likely be exacerbated. Lower anticipated returns on industrial investment due to resource depletion and transportation costs would also likely play a role identifying reasonable rebuild efforts. Lastly, risk to state-wide economic development efforts is presented by these coastal node communities due to their provision of local support to Juneau: the central decision making point for many of Alaska's transportation and economic development systems.

State-wide Development Risk Overview		
Natural	***Security***	***Economic***
Resource Exhaustion	Emergency Response Communication	Resource Costs
100 Year Disaster Events	Military Mobilization Times	Expertise Limitations
Seismic Episode	Critical Supply Bottleneck	Transportation Reliability
Cyclical Natural Events	Industrial Attack or Accident	Market Stability
Ecological Disruption	Power and Fuel Delivery	Energy Costs

Rail Mitigation: Providing rail access to South Eastern Alaska would offer not only protection against risks of port debilitation, but also against the risk of transportation costs limiting the long-term competitiveness of the region's commodities. Terrestrial transport would permit the local development of timber and fishery products without the costs of airfreight or low volume sea transportation. If any seismic or industrial accident were to restrict air and sea transportation in the region, the rail connection could be used as an interim supply line and repair coordination tool. Rail communication and power systems may also be used to facilitate emergency response efforts in the even that the traditional systems were disabled.

3.3.3 Anchorage Inter-modal Facilities –

Anchorage represents a crossroad of Alaska's geography as well as modality. Not only the mid-point of East-West marine and air traffic, Anchorage is also the primary intersection point between most of Alaska's transportation network links. By allowing interaction between marine, rail, air, truck, satellite, and microwave transportation methods, Anchorage offers a convenient consolidation, parsing, and assembly location for all of Alaska's products except the TAPS based crude oil transport.

Primary Transport / Purpose: The strategic location, ample population base, and considerable infrastructure supporting Anchorage's inter-modal facilities make it the probable site for value-added resource development. The long distances between Alaska's markets dictate that most products, whether materials, communications, or tourists, must leverage bulk transport to enter or leave the state. In order to compete in global markets, Alaska's products and supplies must pass through bulk consolidation and reduction processes before relay within the state or in preparation for intercontinental travel. As a prime location for value-added processing and the primary intersection between transportation network components, Anchorage's inter-modal facilities are a vital node in almost every person's, product's, or data's trip into, or out of, Alaska.

Principal Risks: A mission critical enabling node for almost every network component in Alaska, any capacity reducing incident in Anchorage's inter-modal system puts the entire state at considerable economic and personal safety risk. When considering the importance of Anchorage's facilities in supporting military and petroleum development operations, any risk to these systems also threatens America's national security effectiveness. An important component in national economic and security solutions, Anchorage's inter-modal capabilities defy an extensive array of natural, economic, and human risks.

Economically, the long-term viability of Anchorage's inter-modal solutions are constrained by the prospect of natural resource depletion, market volatilities, and terrain based transportation limitations.

- Cook Inlet and South Central natural gas and mineral deposits are likely to see a decline in production within the next 10-15 years; due to the limited range of existing local transportation resources, local supplies of critical industrial inputs are vital to Anchorage's continued economic development.

- Fish, oil, and raw natural resources are all commodities with notoriously fickle market potential; technology development, consumer tastes, and international competition are all unknown variables in the future of Anchorage's ability to leverage its inter-modal functions.

- Limited developable land and some of the world's most aggressive tides will always confine Anchorage's inter-modal economic growth potential; the same geographic attributes that make the area so strategic also present daunting challenges in the form of coastal building complications and constraints of space for housing and industrial development.

Terra's dynamic nature precludes anyone from natural disaster immunity; no amount of planning, design, analysis, development or investment will insulate a community from the potential effects of natural disaster. That said, Anchorage's ability to effectively transfer and organize Alaska's freight is faced with more than its share of natural disruption risk. Fault lines, volcanoes, combustible forests, destructive weather patterns and treacherous marine environments surround and transect Anchorage's housing, transportation and industrial facilities. While many of these environmental factors may interact without disabling the transportation node itself, all of them have the potential to wipe out energy production or cut off communication, rail, air, or truck transit routes. With any one of these node components disabled, the ability of the system to function is greatly diminished.

Lastly, the Anchorage inter-modal capabilities interact with human factor risks in addition to the previously discussed economic and natural challenges. The ability for the Port of Anchorage, the Anchorage International Airport, the Alaska Railroad and local military installations to coordinate the support of international military operations is critical to the effectiveness of national defense efforts. As such, the area, and more particularly the infrastructure, enabling effective transfer of personnel and equipment from long-range transport to local effectiveness would be a prime target for hostile attack. Other human factor risks are the closeness of industrial development to transportation facilities, and a considerable lack of infrastructure redundancy; since few transportation requirements have more than one potential access point, all points of contact between industrial development and its primary transport system present the risk of an industrial accident disabling one or more of Alaska's limited transportation solutions.

Common Alaskan Transportation Impact Risks		
Industrial Accidents Flood and Erosion	Offensive Measures Earthquake & Volcanic Episode Infrastructure Failure	Forest Fires Tsunami Landfall

Rail Mitigation: A rail line through Canada offers would most affect Anchorage's inter-modal risks by providing alternative supply routes for interior and South Central Alaska. If an incident were to interrupt the transfer of materials between land and sea in Anchorage, the state could either take advantage of the strictly terrestrial rail route to the Midwest or leverage spur lines to South East ports for interim supply provision. In addition to providing alternate high volume supply routes, a transcontinental rail link would permit many of Alaska's future industrial developments to take place further from the state's population center, and thereby lower the probability of coincident industrial / natural disasters. Distributing inter-modal responsibilities would ultimately lower the transit to market risks for all of Alaska by permitting the migration of development to lower energy, land, and resource risk locations.

3.3.4 Fairbanks Inter-modal Facilities –

Fairbanks's inter-modal facilities are the northern counterpart for those in Anchorage. Much of the consolidation, less than truckload, and production work that takes place in Anchorage is in preparation for travel to or from its corollary function in Fairbanks. As the primary transportation junction for rail, truck, and communication interchange in Northern Alaska, Fairbanks allows modal interchanges between the Dalton Highway, the rail line to Anchorage, truck traffic to Anchorage, and the Alaska Highway. Given current plans for a rail line to Delta Junction, these facilities may soon provide modal transfer for rail traffic to and from military training operations in the interior of Alaska. While lower in volume, these facilities also serve a vital function in their ability to supply interior Alaskan villages along the Yukon and Tanana Rivers.

Primary Transport / Purpose: The most commonly referenced function of the Fairbanks inter-modal node is the ability to compile North Slope supplies from air, truck, and rail sources into truck shipments for travel up the Dalton Highway. In addition to these North Slope support functions, heavy industry support is provided by fuel oil refinement facilities in North Pole that extract some of the TAPS oil for local conversion to fuel. Lastly, the Fairbanks inter-modal node operations support the conversion of local community commodities from long-range transport forms such as airlift or railcar into smaller units for retail and community level distribution systems.

Principal Risks: Extensive forest fire risks, refinery accident potential, and the proximity of military operation and training facilities all place the Fairbanks transportation at risk for short and long-term disability. Due to the long distance to the next nearest industrial or economic base, Fairbanks is a critical transportation node for emergency management, economic maintenance, and long-term community survival. The capacity for weather or natural disaster to isolate the interior of Alaska from the South Central supply lines places Fairbanks in the role of a capacitor that stores up commodities and industrial supplies to sustain interior and Western Alaska communities in the event of a disabled link to Anchorage. Most Interior, Northern, and Western supplies that are not manufactured locally will receive their final processing in Fairbanks, so any disruption of this node would render all other components of the Northern Alaska transportation network ineffective for community sustenance, industrial development, and emergency management.

Rail Mitigation: An Alaska Canada rail connection would provide direct rail access to many of the Eastern and Central Alaskan communities that currently rely exclusively on Fairbanks for supplies. The city of Fairbanks itself, and all of the derivative economies across the state, currently must take advantage of the rail to road transfer capabilities found at the inter-modal facilities. The creation of a terrestrial link that does not rely on traffic through Anchorage would allow for distributing the rail to road transition functions along the line, rather than just in Fairbanks itself. Because equipment, chemicals, and supplies could be brought up through Canada rather than via the Port of Anchorage, the consumer markets in Central Alaska could be far more certain that their products could be delivered, even in the event of a debilitating accident in Fairbanks or along the North \ South line.

3.3.5 Tok, Glenallen, and Delta Junctions –

These critical highway intersection points represent decision and redundancy nodes within the Alaskan road network. The triangle formed by these three nodes provides an array of options for truck based access between the interior of Alaska, the Alcan freight route, and South Central tidewater ports.

Primary Transport / Purpose: The two primary functions of these three nodes are to provide truck access between the Lower 48 and Alaska's two main population centers, and to offer a redundant method for Anchorage / Fairbanks traffic. Due to the high probability of a seismically induced break in the rail, fiber, and road connections between Anchorage and Fairbanks, this cluster of road connections fulfills a vital role as a backup supply route for industrial and human safety transports to the interior of the state.

Principal Risks: Local community supply and small load commodity shipments from the Lower 48 states represent the greatest risk factors for this transportation node. Forest fires and floods are constant threats throughout these communities, but a more probable situation would be the overload of road capacities in the event of a disaster elsewhere in the state. Due to the limited traffic and long distances, these roads could prove a challenge for maintenance if their throughput were suddenly increased in response to economic or security stimuli.

Rail Mitigation: An Alaskan disaster that requires tidewater access for supply, equipment, or troop movement, would quickly overwhelm the limited capacities of these roadways. The creation of an alternate terrestrial link with the rest of the country could prevent the breakdown of these supply paths by leaving them for normal truck and auto traffic. Heavier equipment and supplies could be either brought up through Canada, or sailed as far as South East ports and placed on rail for the remainder of the journey.

3.5 Transportation Link Risks

Transportation Links: Transportation network links are the single mode routes that connect communities and nodes to each other. The primary risk posed by the destruction of a network link is the temporary isolation of the communities served by that link. The relative lack of route redundancy within Alaska places many areas into constant dependence on a single link. In some cases, however, the destruction of a link may have a profound impact on all of Alaska. The primary risk links are the TAPS, the Alcan, and the road / rail belt connecting Anchorage and Fairbanks.

3.5.1 Alcan Highway System –

The Alcan road system is a combination of the Alaska Highway and several Canadian highways that form a continuous roadway between central Alaska and the primary road systems of Southern Canada and the Contiguous United States.

Primary Transport / Purpose: The Alcan Highway is the primary transport method for commodity transport between Alaska and the rest of the country. As the only terrestrial way of transporting goods between Alaska and the rest of North \ South America, the Alcan is a vital enabler of economic, emergency management, and resource management efforts.

Principal Risks: The highway's length and many treacherous landscape crossings make this transportation link one of the most prone to failure. Avalanche, flood, and forest fire regularly stop flow along this route for shorter periods of time; a bridge failure, landslide, or fault rift could prevent truck traffic from entering Alaska for longer periods of time. Lastly, the capacity of this line is limited by the maintenance and continual renewal efforts required to keep the roadbed in operating condition. A large scale industrial or military mobilization using the current road system could quickly degrade the surface beyond usability.

Rail Mitigation: As Alaskans continue to develop the many natural resources throughout the state, the throughput demands on the Alcan will necessarily increase. If technologies continue to free up more areas of Alaska for value added resource development, the highway system will not be able to hold up under the increased loads and traffic frequency. A rail connection that permits equipment and material transport without routing through Anchorage would provide a far less expensive system in terms of maintenance and repairs, not to mention reliability.

3.5.2 North / South Rail Line & Parks Highway –

Operated by the Alaska Railroad Corporation, the railroad connecting the Port of Anchorage, the Ted Stevens International Airport, and the Kenai Peninsula to Fairbanks inter-modal facilities is the primary large freight transport method between tidewater resources and the interior of Alaska. The Parks Highway is the most direct passenger and truck roadway connection between Fairbanks and South Central Alaska with extension to tidewater port facilities.

Primary Transport / Purpose: Chemicals, oilfield equipment, and bulk raw materials are all large scale transportation opportunities for the railway. Passengers and local community supplies are also carried North and South via the railroad system. The minimum shipment size for effective rail transport is approximately 60,000 pounds. As such, freight and passengers traveling between Anchorage and Fairbanks that require more regular delivery or warrant smaller shipments are the primary candidates for Parks Highway truck traffic.

Principal Risks: As the principal method for transporting oversize loads across Alaska, the prospect of rail debilitation or increases in cost would make extraction industries throughout Alaska hard pressed to compete in global markets. While the primary enabling infrastructure for oil delivery is the TAPS, the most critical component of oil industry supply is almost certainly the Alaska Railroad. In addition to the ever present threat of destruction by earthquake, the lack of redundancy and many treacherous passes along the route provide ample opportunity for natural or mechanical accidents to shut down rail service. Vast acreages of forest land prone to lightning strikes also provides the potential for forest fire induced service cancellation, while river crossings provide the possibility of bridge failures and flood damage.

Traversing the same seismically active terrain as the Alaska Railroad, most of the same risks apply to the Parks Highway. Additionally, concerns over weather, floods and forest fires apply to any critical transport via the Parks highway. As a primary supply route for many communities along the way, the Parks Highway will continue to be an important enabler of internal Alaska economic development.

Rail Mitigation: Because both the railroad and highway system cross the same risk zones, there is a strong possibility that any emergency that disables one will disable them both. As such, an alternate method of transporting both tidewater products and cross country products would be critical to rebuilding and re-routing prospects. Certain amounts of traffic might be routable from Valdez through Delta Junction, but any long term shut down of this critical North \ South corridor would limit the effectiveness of Fairbanks, North Slope, and interior Alaska market operations. A rail connection to tidewater and American markets would dramatically reduce the risk to all Alaskan markets from an event along this route.

3.5.3 Fiber Optic Connections –

GCI maintains a pair of fiber optic links between Alaska and the Lower 48 States. By connecting South Central Alaska and Juneau with the rest of the country, these lines provide a stable and high-throughput conduit for operational and personal communications.

Primary Transport / Purpose: A minimum of 110 billion bits per second may be transmitted via the redundant fiber ring pictured below, making this network link the preferred and economical method of transmitting offshore communications. Satellite connections are less prone to terrestrial events, but their costs and limited transmission rates drive a continued reliance on fiber optics for primary population center communications.

Principal Risks: Unknown fault events, landfall interruptions, undersea entanglements, and hardware failure are all potential risks to the fiber optic link. Additionally, the connection between Anchorage and Fairbanks is not double routed, so the possibility of a single seismic event severing both primary communication and transportation routes between these cities is of concern. Microwave tower based communications may provide limited emergency communication backup, but the sensitivity of microwave alignments prevents this backup system from reliably providing emergency service.

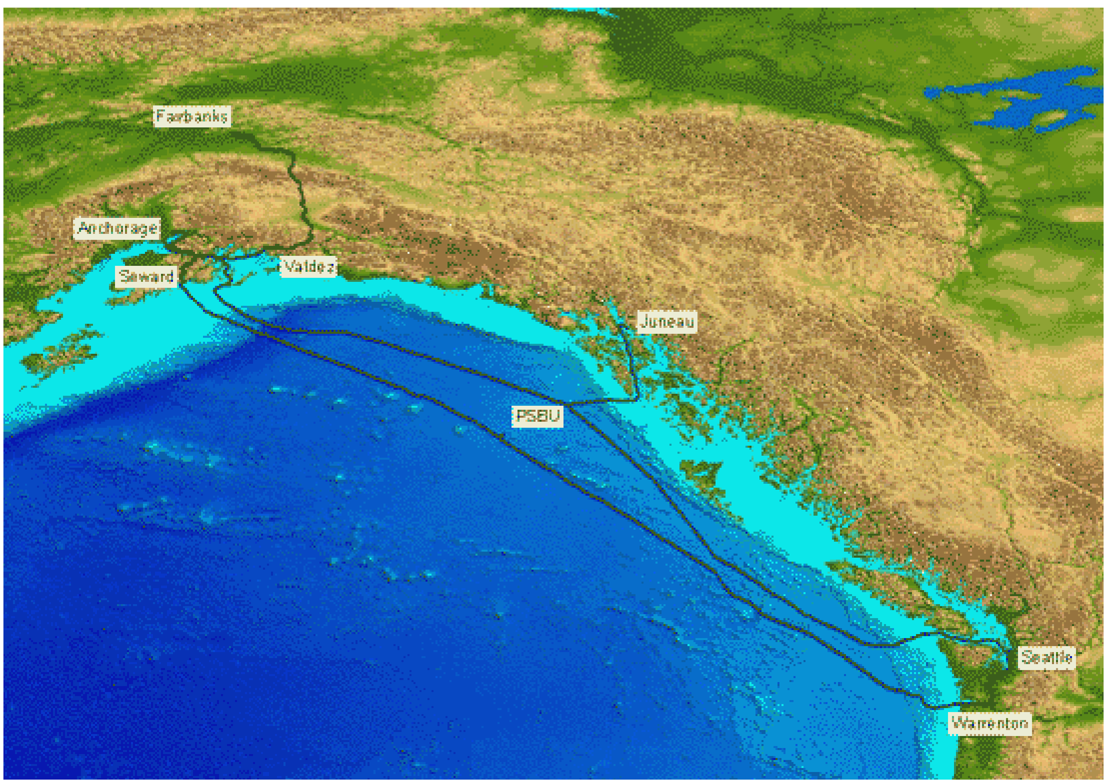

Figure 42: GCI Alaska United Fiber System[14]

Rail Mitigation: A rail connection through Eastern Alaska could reduce the risk of community isolation in the region in several ways if developed in conjunction with existing emergency response communication plans. Because the positive trail control system will require continuous communication with the Alaska Railroad headquarters in Anchorage, a system of microwave, satellite, or fiber relay sites will

[14] Statewide Fiber Concept

undoubtedly be developed along the route. If the capacity is built in for community taps, this relay solution could also be used by emergency responders in the area.

Another fiber communication redundancy solution would be the prospect of a fiber cable being placed along the track route as part of the rail bed creation process. This solution would provide easy cable access for local community stub maintenance as well as for any necessary repairs to the line. A series of satellite uplink sites as part of the system would support the continued operation of the system if some portion of the line were to be severed.

Together, the dual prospects of train control derived emergency communications and the potential for a shared fiber \ rail belt to the primary North American circuits would offer considerably more coverage and reliability to fiber optic communication systems in Alaska.

3.5.4 Trans-Alaska Pipeline System (TAPS) –

Put into service in 1977, the TAPS is a series of pipe segments and pump stations that transects Alaska from North to South carrying North Slope crude oil to the North Pole refinery operation and to the Valdez processing and port facilities.

Primary Transport / Purpose: The Trans-Alaska pipeline has served Alaska for almost thirty years as the primary transport method for conveying Alaskan North Slope crude oil to high volume sea access. By providing single mode transit across the state, the TAPS offers a low overhead / low risk first leg in North Slope oil reserve conveyance to market. While there is an outlet for fuel oil refinement in North Pole, most of the oil entering the pipeline on the North Slope is relayed via a series of automated pump stations to Valdez, where it is either refined for Alaskan markets or transferred onto ocean tankers for delivery to global markets.

Principal Risks: By providing continuous transport across the entire state, the TAPS is exposed to every possible natural risk in Alaska. Earthquake caused ruptures, permafrost melts, and flood based support erosion are just a few of the natural risks that befall the pipeline. Additionally, the pump station system and the infrastructure at either end are obviously infrastructure failure risks. As an exposed target covering vast areas of unmonitored territory, the TAPS may also be considered a high possibility target for domestic or international attack.

Rail Mitigation: If the TAPS were to become inoperable, Alaska's North Slope petroleum exports would grind to a halt due to the exclusive reliance on the pipeline for product delivery. By building an Alaska Canada rail link, developers would support potential repair efforts, lower operational costs, and help to diversify the North Slope economy.

1. Rail car transport from the Mid-West could lower chemical and tubular delivery costs to any repair efforts.

2. Providing rail as a method for carrying petrochemical derivatives to market could support the development of material exports to augment the crude exports in case of an economic emergency.
3. The improved natural gas pipeline prospects provided by the rail connection would increase the probability of developing gas as a complementary product for North Slope export.

3.6 Conclusion

Planning and coordination compound over time to either betterment or detriment: natural risks will grow with increased reliance on non-redundant solutions, while habitat and natural resource values can expand exponentially with proper planning. Emergency management complications will only increase as time and technology leave Alaskan communities disconnected, while dramatic response effectiveness increases may be realized through simple considerations within existing project plans. If designed with risk mitigation in mind, the Alaska / Canada Rail Link has the potential to dramatically reduce the impact of current transportation system failure while providing the building blocks for long-term market stability.

Markets do not wait for laggard developers. Good things may come to those who wait, but competitive markets do not. By failing to invest and plan now for global requirements tomorrow, Alaska runs the tremendous risk of missing the best opportunity for commodity value expansion since the oil crisis of the 1970's. The upcoming global economic powerhouses are all positioning themselves to support the explosive growth in Asian markets. By planning to reliably and economically supply products, commodities and services to these consumers, Alaska is investing in a sure future; failure to do so will result in competition with those same consumers.

Continued effort to encourage industrial development while the state remains a single seismic event away from complete market isolation is only increasing the potential loss when the inevitable occurs. Another seismic disaster in South Central Alaska is not a question of 'if', but a matter of 'when.' Alternate mass transport and tidewater access is equally an investment in Alaska's competitiveness and Alaska's security. If Alaska's security is not a sufficient encouragement, one should consider the immense global implications of a 100% terrestrial connection across the North American continent; it is almost impossible to quantify the balance of power improvements gained by an alternative to the Suez Canal for connecting Alaska and the defensive resources of the Eastern Seaboard.

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