Pricing Royalty Crude Oil

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TABLE OF CONTENTS

I. Executive Summary

In the December 30, 1999 *Federal Register*, the Minerals Management Service (MMS) proposes to tie royalty payments for oil produced on federal leases to the prices of benchmark crude oils. In the case of California crude oils, royalty payments for oil not transferred at arm's length are to be based on an Alaska North Slope (ANS) spot price index. The MMS would make allowances for location and quality differences between royalty crude oils and the index, but the methodology is ambiguous and could be extremely difficult to implement.

ANS is not a good basis for valuing California crude oils. ANS is a blend of crude oils produced in a wholly separate petroleum province and it is economically distinct from California crude oils. *Reuters*, *Telerate*, and *Platt's Oilgram* have collected spot price information on ANS delivered to California and the prices of several California crude oils for over a decade. Line 63, for example, is a California crude oil stream that has a similar API gravity and sulfur percentage to ANS. It is priced in the Los Angeles Basin not far from where ANS is landed. Both crude oils are widely traded by refiners in the region. Over the last decade, ANS has generally sold for a higher price than Line 63. Moreover, the difference in market value between the two crude oils fluctuated widely even after adjustments for gravity. Similar conclusions are drawn when ANS spot prices are compared to two heavier California crude oils, Wilmington and Kern River.

API gravity is the most frequently used measure to estimate the quality of a crude oil. Generally, heavy crude oils have a gravity of less than 20° and light crude oils measure more than 34°. Differences in API gravity are often used to estimate price differences among crude oils from the same or similar fields. They should not, however, be used to determine price differences across different crude oil families. Even though ANS is a medium gravity crude oil it has frequently sold for more than crude oils that are lighter.

The methodology underlying the MMS proposal would tie royalty values in non-arm's length sales to an index of either WTI or ANS prices. Using this methodology, prices are determined in market centers, and field values are determined by subtracting transportation costs and other adjustments from the delivered value. This methodology is not, however, appropriate for the crude oil market, where production from large fields may flow to a variety of market centers using a variety of transportation modes. In a multi-dimensional system of production and delivery, market value is determined by the complex interaction of many variables. These variables cannot usually be broken down into a simple formula to adjust for differences in quality and location.

The MMS proposal is aimed at simplifying the valuation of royalty crude oils, but it is unlikely to do so. If royalty values are to be based on market values, then price indexes, such as ANS, must be adjusted for market-based quality and location differentials. Even if these data were available, the MMS has not outlined adequate procedures for collecting such information. The choice of proxies for market-based adjustments—from posted price bulletins or pipeline gravity banks—could cause estimated royalty values to deviate significantly from market values. While the proposed procedures are intended to increase federal revenue, there is no guarantee of this outcome. In any case, the arbitrary calculation of quality and location adjustments is bound to be expensive, time consuming, and controversial.

The market value of a commodity is nothing more or less than what it will sell for in an open market. The best way to measure market value is to observe prices in actual transactions. This has been a guiding principal of royalty valuation for decades and it should not be abandoned. Crude oil is not a simple commodity and determining prices for the thousands of U.S. fields is no simple matter. Unfortunately, the MMS has rejected the industry's proposed "comparable sales model" which has the potential to yield reasonably accurate prices for production not sold at arm's length. The MMS's latest proposal has not simplified the problem of determining the royalty value of various crude oils; it has made it more complex.

II. Credentials, purpose of report, and summary

A. Credentials

I, Samuel A. Van Vactor, am an economist, President of Economic Insight, Inc. and researcher at the University of Cambridge, Scott Polar Research Institute. Formerly, I was an economist at the U.S. Treasury in Washington, D.C. and a senior economist at the International Energy Agency of the Organization for Economic Cooperation and Development (OECD) in Paris, France. My educational and professional background is detailed in my resume in Appendix A.

Since 1973 I have specialized in energy economics. I am the author or co-author of a number of books and articles concerning the petroleum market. These include *Competition In The Oil Industry*, "Retrospective on

Oil Prices," "Prospective on World Energy Markets: Real Costs will Continue to Fall" and "Time to End the Alaska Oil Export Ban." Economic Insight's current publications include the *Energy Market Report*, a daily report on electricity pricing in North America.

I am a founding member of the International Association for Energy Economics; I have served on its board and chaired the 1993 North American conference in Seattle. I have been a consultant or advisor to the Internal Revenue Service, the Bonneville Power Administration, U.S. General Accounting Office, the Congressional Research Service, and state and local agencies in Alaska, California, Idaho, Oregon, and Washington. I have spoken on energy economics throughout the United States, and in Canada, Hungary, England, India, Singapore, South Africa, China, Japan, Australia, Venezuela and France.

Much of my research activity has concerned the West Coast oil market. I have been a consultant or advisor to the Alaska Senate finance committee, the North Slope Borough, NYMEX, the California Independent Producers Association, the Alaska North Slope producers, and various crude oil producers in California.

B. Purpose of the Report

The American Petroleum Institute (API), the Independent Petroleum Association of America, the Domestic Petroleum Council, and the U.S. Oil and Gas Association have asked me to review and comment on the Minerals Management Service's further supplementary proposed rule for Establishing Oil Value for Royalty Due on Federal Leases as published in the Federal Register on December 30, 1999. In particular, I have been asked to comment on the appropriateness and validity of using spot prices of Alaska North Slope (ANS) crude oil as an index against which to measure the value of various crude oils produced from Federal leases in California.

C. Summary of Findings

1. ANS, which is a blend of various crude oils produced on Alaska's North Slope, is economically distinct from California crude oils and is unsuitable for determining their royalty value unless market-based quality and location adjustments are applied.

2. Spot market data demonstrate that ANS crude oil is not comparable in quality to California crude oils of similar API gravity. Usually ANS commands a premium over California

crude oils and the relative values of the two types of crude oil fluctuate substantially.

3. The MMS proposed pricing methodology is unfit for the crude oil market, where oil is frequently shipped in many directions. Although the methodological change may be intended to enhance royalty revenue it could just as easily reduce it.

4. The market value of a crude oil is determined by many factors. These include supply and demand for petroleum-based products, the quality of the oil, location of the sale, transportation alternatives, logistical considerations, and the configuration of refineries prepared to process the feedstock.

5. Gravity-price differentials published in posting bulletins and used by pipelines for shipping California crude oils are intended to adjust for small differences in gravity from crude oils from the same or nearly identical fields. They should not be used to determine value differentials between dissimilar oil fields or when gravity differences are substantial.

6. In most instances, quality and location differentials in exchanges and buy-sell transactions are combined, rather than separately stated. The MMS methodology, which aims to calculate transportation costs and quality adjustments separately, would be quite cumbersome to implement for California crude oils.

7. Rather than simplifying Federal royalty valuation of non-arm's-length transactions, the MMS proposed methodology would make this valuation more difficult and subject to considerable controversy.

III. Alaska North Slope Crude Oil

A. Alaska's Oil Fields

ANS is mainly a blend of crude oils from seven fields on the North Slope of Alaska. The principal field is Prudhoe Bay, the largest oil field ever discovered in the United States. ANS production peaked in 1988 at about two million barrels per day. Despite the development of surrounding smaller fields and enhanced oil recovery in Prudhoe Bay, ANS production has declined since its peak. Production for 1999 will be just over one million barrels per day.

The quality of crude oil in the North Slope oil fields varies considerably. Kuparuk, the second largest field, is heavy, with an API gravity of about 22 degrees. One of the newest discoveries, Pt. McIntyre, is a high quality crude oil of approximately 40 degrees. The Prudhoe Bay field also has large quantities of natural gas. Two processing plants have been added which inject natural gas liquids (NGLs) into the crude oil stream, which has the effect of increasing API gravity. In addition, refineries in Alaska withdraw ANS from the Trans Alaska Pipeline System (TAPS). These refineries "top" the crude oil to make light petroleum products and return the residual to the pipeline where it is blended with the whole crude oil. The mix of crude oil, NGLs, and residuum constitutes the crude oil stream known as ANS.

Although the composition of ANS has changed slowly over time (in recent years becoming lighter), the quality of the blend is very predictable. The decline in production, however, has had a substantial impact on ANS trade. In 1988, the point of peak production, the West Coast could not absorb the combined production of ANS and California crude oils. The surplus had to be shipped to the Gulf Coast despite the high transportation costs entailed. The surplus put downward pressure on West Coast crude oil prices. Reduced ANS production combined with removal of the ban on crude oil exports has eliminated the glut. At the same time, however, it has reduced the volume of ANS sold and diminished its role as a price "marker" for the region.

Alaska's North Slope is a wholly different crude oil producing province as compared to California. ANS has different refining qualities from California crude oils. It is a waterborne crude oil landed at California's two largest refinery centers—the Los Angeles Basin (LAB) and the San Francisco Bay Area. ANS is handled separately from California crude oils. It is transported and stored separately, and to my knowledge it is not commingled with California crude oils until finally processed by refineries.

B. Spot Price Comparisons: ANS and California Crude Oil

ANS and California crude oils compete for utilization in California's refineries. However, since most California crude oil is much heavier than ANS there are few opportunities for a direct comparison of prices. One California crude oil stream that is not too different from ANS is "Line 63." This crude oil is also a commingled stream; it is similar in density and sulfur content. It is delivered in the L.A. basin, reasonably close to where ANS is landed. A comparison of spot prices for ANS and Line 63 crude oil in the

1990's shows that the market priced ANS more highly, and, further, that the price relationship between the two oils varied significantly from month to month. Table B-1 shows the unstable nature of this relationship, based on spot prices, the very source of the index that the MMS proposes to use. This table gives the monthly average spot prices published by Reuters for ANS-West Coast (Column 1) and Line 63 (Column 2). On average, ANS sold for $0.85 more than Line 63.

A direct price comparison can be somewhat misleading, because ANS has a slightly higher API gravity than Line 63. In Table B-1, the Line 63 price is "adjusted" to the ANS gravity (Column 4) using the gravity-price differential contained in the Chevron posting bulletins (Column 3). (Section VI explains why gravity adjustments by themselves are not adequate to explain differences in crude oil market prices.) Column 5 shows the difference in spot prices for these two crude oils. ANS has usually sold at a premium to gravity-adjusted Line 63 oil. The price differential has ranged from a low of -$0.19 in September 1990, to a high of $2.26 in March 1992, for an average of $0.68 over the ten-year period. Figure B-2 graphs this differential over time, clearly demonstrating the variability of this price relationship.

Spot prices are also published for two additional California crude oils – Wilmington and Kern River. Table B-3 lists spot assessments for ANS and Wilmington crude oils from July 1990 through December 1999. Here a price comparison is not so easily made, because Wilmington crude oil is much heavier than ANS. Column [1] is the average price assessment of 29° ANS. Column [2] is 17° Wilmington. To make these prices comparable, the much heavier Wilmington crude oil spot prices must be adjusted upward to reflect the 12 degrees of difference. The third and fourth columns list gravity-price adjustments from Chevron's bulletins during the relevant time periods. Column [5] shows the gravity-adjusted Wilmington "price" at a 29° equivalent.

The results are similar to the comparison made between ANS and Line 63. Through this period, ANS spot price assessments at the landing dock were, on average, $1.03 per barrel higher than the gravity-adjusted Wilmington spot price assessment. This figure actually understates the quality difference, because ANS prices do not include offloading and other logistical costs of moving the crude oil to a refinery. The Wilmington field, on the other hand, is close to the refinery gate. The price series reflect even more variability than seen in the Line 63 ANS comparison.

Location was not an important factor in the price comparisons just made, since the points of delivery were within a few miles of each other, adjacent to a number of interconnected refineries. Most California crude oils are, however, produced some distance from the Los Angeles Basin or the Bay Area. In these instances it is difficult to untangle the impact of quality and location on price differences. The Kern River oil field, for example, is located in the eastern San Joaquin Valley, far from a point where ANS is delivered. Kern River oil is shipped west and north to the San Francisco refining center.[1] Adjusting for the differences in gravity using the gravity-price differential in Chevron's Kern River postings should (if the MMS approach is correct) yield a stable difference in price between the two oils, reflecting the difference in location or transportation costs. As Table B-4 demonstrates, however, the difference between the spot price of ANS and the gravity-adjusted spot Kern River price does not appear to represent solely a transportation cost difference.

C. Quality and Logistical Characteristics

Why are refiners willing to pay more for ANS than most California crude oils? In most instances it may simply be superior refining qualities (many of which are not explained by API gravity differences). ANS can produce a higher proportion of gasoline, jet fuels, and diesel (the products most in demand) than can most California crude oils. But there are other factors too, such as sulfur content. ANS has frequently sold for prices similar to the landed price of Arabian Light, even though ANS is heavier.

Virtually all of California's high-volume refineries are located near tidewater. In such locations they can pivot between onshore pipeline deliveries of crude oil and offshore crude oils, such as ANS. Pipeline deliveries do not offer much flexibility; the pipelines connect particular crude oil fields to the refinery. The refiner is locked into specific production profiles of the onshore fields. Not much can be done about changes in quality or production rates. In contrast, once crude oil is loaded on a tanker it can be delivered to a multitude of refineries. Moreover, individual refineries located near tidewater may choose from a wide variety of cargoes, selecting the one best suited to balance current feedstocks. Tanker deliveries can be delayed or sped up. In short, a refiner or producer has considerably greater flexibility with waterborne deliveries than with pipeline deliveries.

[1] Kern River oil is also refined in the Bakersfield area and is sometimes transported south to the L.A. basin refining area.

ANS producers in particular have been advantaged by their ability to deliver the crude oil to a wide variety of refiners in their own or chartered tankers. Onshore crude oils have limited outlets and a scarcity of storage options. Even if the producer owns pipelines, the number of onshore buyers is restricted. This flexibility has given ANS producers a competitive advantage.

ANS has had another advantage: the oil is delivered in large volume shipments. On the other hand, California crude oils, particularly light and medium gravity crude oils, are spread throughout six producing regions. Purchases are most often arranged in small lots. Put simply, the transaction costs to the refiner are smaller on a per barrel basis when dealing with a high-volume crude oil, and this allows them to offer a higher price per barrel.

In marketing ANS, the producers have had the flexibility to choose among many buyers at refinery centers in Hawaii, Puget Sound, the Bay Area, and the Los Angeles Basin. And, if reasonable sales could not be made in these markets, the oil could be shipped to the Gulf Coast. This has allowed ANS to be marketed to those refiners that had the most immediate demand and were willing to pay the highest prices.

IV. The Problem of Index Pricing

The underlying theoretical structure proposed by the MMS values oil at the point of production by observing an index price in a market center and subtracting transportation costs and other allowed adjustments. Implicitly the methodology assumes a simple relationship between production, transportation, and quality. In fact, the North American crude oil market works in quite a different fashion.

Consider the heavy crude oil fields in California's central San Joaquin Valley. These fields produce nearly half of the state's total oil output. The Valley is cross-connected with a whole series of pipelines, trucking terminals and rail transport. For example, crude oil from the Midway Sunset field can be shipped to Bay Area refineries, the Los Angeles Basin, refineries in Bakersfield, and the California Coast for delivery to Puget Sound and elsewhere. For many years the crude oil could even be shipped to Texas through the All-American pipeline. The first question the MMS has to resolve is where is the market center? Which transportation costs should apply? Would market centers and transport costs vary from one producer to another? Does this mean that every producer would pay a different royalty value for the same oil? If the index were based on a crude oil with different refinery or economic characteristics how would quality adjustments be made?

In the complex and dynamic oil market, the market value of crude oil at its field will rarely correspond to the value at a particular market center less regulated or predetermined adjustments. The dynamics of the market would not easily accommodate the regulatory time lag. It has been the general presumption that index pricing would result in higher valuations for royalty purposes. This may or may not prove to be the case.

Domestic crude oil production is declining, particularly in well-developed provinces. Ownership of transportation facilities, rates of utilization, quality of production (of the oils at the leases and of the indexes), and many other factors are constantly changing. Since the proposed methodology is not based on actual market prices, it could yield a higher or lower payment.

V. Determinants of Crude Oil Value

A. Introduction

Crude oil, particularly California crude oil, is far from homogenous. The exact chemical composition of crude oil varies with every field and in some instances from pool to pool within a field. Quality differences have a significant impact on the cost of refining particular crude oils and on the types of products the oil will produce. Refiners do not treat one crude oil as an exact substitute for another; some oils are much more valuable than others are. What refiners will be willing to pay for a given crude oil depends on many factors. Some of these factors include the processing units in place at the refinery, the strength of demand for the products expected to be refined from the oil, the number and types of refinery feedstocks that might substitute for it, and processing costs specific to the particular crude oil.

Location is another important determinant of the price a refiner will offer for a crude oil in the field. If the oil is close at hand and can be quickly and cheaply moved, it will be worth more than one of equivalent quality that is a long distance away and/or requires expensive modes of transportation. However, as noted, the impact of location on crude oil field prices is complex. Not only does it depend on the location of the crude oil field, but also on the locations of multiple refiners that can process the oil, and the type of transportation available to move it.

B. Quality

The most commonly used measure of crude oil quality is a simple measure of density -- API gravity, a formula specified by the American Petroleum Institute. Sulfur and other characteristics are also taken into account by distinguishing between fields and various crude oil blends. The API gravity of most crude oil ranges from around ten degrees to sixty degrees or more for natural gasolines and natural gas liquids. A crude oil with an API gravity of less than twenty degrees is normally considered heavy; twenty degrees up to thirty-four degrees – medium; and, thirty-four degrees or higher is considered light. (Precise definitions vary with the petroleum province and marketing circumstances.)

Within a crude oil type, API gravity is a reasonable predictor of crude oil yield, i.e., the percentage of various petroleum products that can be refined using a simple distillation process. In less complex refineries heavy crude oils produce a preponderance of lower-valued residual or heavy fuel oil. Light crude oils produce a greater volume of higher-valued lighter products -- diesel, jet fuel, and gasoline. Table B-5 demonstrates the relationship between gravity and yield for thirteen California crude oils. As gravity rises the percentage of heavy fuel oil from simple distillation declines. The statistical correlation of the relationship is quite high and, all other things being equal, the higher the gravity of a crude oil, the greater its value.

The petroleum industry accounts for the impact of gravity on crude oil value through gravity-price differences in postings and gravity banks on pipelines. Typically, crude oil prices are discounted from 10 to 40 cents per degree below a given price level for every degree of gravity reduction. (Or added to the base price, if the gravity of the given crude oil is higher.) The gravity-price differential changes from time to time as market circumstances change. It is, however, important to note that gravity-price differentials published in postings and used in pipeline gravity banks are normally intended to measure relatively small variations in gravity within a given crude oil type. They are not intended to be applied across crude oil fields or used in circumstances where other important determinants of value vary.

Sulfur content is another important component of crude oil quality. The greater the percentage of sulfur (and other contaminants) the lower the quality of the crude oil and the lower its value. Volumetrically, sulfur reduces the Btu content of the oil; moreover, it is highly corrosive to refinery and logistical facilities and produces products lower in value. As a general rule, heavy crude oils tend to have a greater proportion of sulfur, because sulfur binds more easily to heavy molecules. The same is true for petroleum products; sulfur is usually concentrated in heavy fuel oils. Although it is generally true that heavy crude oils have a higher proportion of sulfur than lighter crude oils it is not always the case. This is why the percentage of sulfur associated with a crude oil is usually cited along with its gravity.

Viscosity (or resistance to flow) is another key aspect of crude oil quality. Crude oils that are highly viscous must either be heated or blended with lighter oils to move them through a pipeline. High viscosity crude oils tend to produce high viscosity fuel oils which are costly to transport and more difficult to burn. Gravity is not a particularly good predictor of the viscosity of a crude oil. Many medium gravity crude oils have a higher viscosity than do lower gravity oils.[2] In California, crude oils with gravity less than 20 degrees normally will not flow through an unheated pipeline without treatment.

In addition to gravity, sulfur, and viscosity there are a host of factors, knowable and unknowable, which contribute to the willingness of refiners to pay more or less for various crude oils.

C. Refining economics

When considering the impact of quality on refiners' willingness to buy particular crude oils and how much they will pay for them, it is important to understand that such demand is derived mainly from the value of the products the oil will produce. Consumers do not directly use crude oil; rather it is purchased by refiners who process it into gasoline, jet fuel, diesel, fuel oil, and other petroleum products. Obviously what refiners are willing to pay for crude oil depends on the cost of refining that crude oil and the revenue they receive from their refined products. Often rising crude oil prices are consequences of improved demand for gasoline or other petroleum products. Rising or falling petroleum product prices do not, however, have a uniform impact on all types of crude oil. If, for example, gasoline prices rise, or heavy fuel prices fall, there will be an impact on <u>relative</u> crude oil prices. The product price adjustments will cause some refiners to buy a lighter mix of crude oils as they seek to produce more gasoline and less heavy fuel oil. This, in turn, will likely cause the price differential between various crude oils to change; heavy crude oil prices will fall and light crude oil prices will rise. Similarly, an unexpected breakdown in sulfur-removing equipment in a key refinery can change the relative value of “sour” and “sweet” crude oils.

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[2] Chapter 7 of the *Fuel Oil Manual*, by Paul F. Schmidt (The Industrial Press, 1951) contains a detailed discussion of viscosity, pages 40-52.

There are a host of other issues with respect to the melange of crude oils available to refiners and the prices they are willing to offer. For example, high concentrations of nitrogen can cause poisoning of catalysts. High levels of contaminants in a refinery's feedstock cause excessive wear and tear on the equipment. These and other problems can increase refining cost. Some of these features are noted in crude oil assays and some are not.

In addition to heavy concentrations of sulfur, many California crude oils are laden with heavy metals, acids, nitrogen, and other contaminants. These impurities adversely impact the prices of these crude oils, because refineries have to be specifically designed to process them and to deal with their corrosive characteristics. Although California heavy crude oil exports have been allowed since 1992, very little trade has developed, reflecting both the high cost of transport and the peculiar refining qualities of these oils.

The most important factor impacting California refining is the preponderance of heavy crude oils. The average API gravity of crude oil processed by California's refineries is much heavier than in other regions. Approximately 70% of California crude oil production has API gravity of 20º or less. (See Table B-6.) California has little heavy industry, severe restrictions on burning sulfur-laden fuel oils, and the most stringent regulations on clean automobile fuels in the U.S. Thus, heavy, contaminant-laden fuel products either have to be exported or recycled for conversion to high-grade gasoline, diesel, jet fuel, and other light products that are in demand. Heavy oil conversion is a complex and costly process, and in the last decade the industry has spent billions of dollars to upgrade refinery facilities.

D. Location

The other important factor determining the price of crude oil in the field is its location. If a refiner has a choice of two nearly identical crude oils, the one with lower transport costs will be chosen, unless the more remote crude oil's field price is reduced to account for the higher transport cost.

Distance is not always the crucial factor in transportation costs, because there are several shipping modes with distinctly different combinations of variable and fixed costs. Generally the cheapest transport per mile is by marine supertanker. However, per-mile costs rise as shipment sizes diminish and distance contracts. Small coastal tankers or barges are often no cheaper than rail or truck, depending on specific location and infrastructure.

On land, crude oil pipelines are usually the least cost mode of shipment. Costs are, however, sensitive to the volume of crude oil being shipped and its quality. Crude oil pipelines that utilize only a small percentage of their capacity or must be heated in order to move high-viscosity crude oils can be quite expensive.

It is important to note that in one way or another, refiners **pay** for transportation whether they buy the crude oil at the lease or at the refinery gate. If they purchase crude oil at a lease and have no transport infrastructure they have to pay pipeline tariffs, tanker, rail, and/or truck charges. If they own transport facilities, they have to bear the cost of maintaining and running the equipment. If, on the other hand, a refiner buys the crude oil on a delivered basis, the same or similar costs must be borne by the seller and these costs are included in the sales price. The seller could have sold the crude oil at the lease at its market value – the price representing the royalty obligation. If instead the seller agrees to deliver the oil, transportation costs will be added to the lease value to derive a delivered price.

Crude oil fields, transportation infrastructure, and refineries all have specific locations. It is not possible to estimate generic transport costs and field values without knowing the details. However, it can be stated unequivocally that crude oil prices in the field are often substantially different than value at the refinery gate. These differences reflect not only the cost of moving the oil to the refinery but the numbers and type of market alternatives and conditions facing refiners and producers.

VI. Market-based Quality and Location Adjustments

A. Introduction

The Minerals Management Service proposes to use average ANS spot prices, adjusted for location and quality differentials, and transportation costs, to value California oil from federal leases sold under non-arm's-length contracts. In this version of the proposed rule the MMS has not indicated how such location and quality differentials are to be calculated (although it might be inferred that they intend to use price-gravity differentials from posted price bulletins and/or pipeline gravity banks). More importantly, the MMS has not demonstrated an understanding of the difficulty of developing and maintaining a valid system of quality and location differentials. Nor does there appear to be an appreciation of the potential arbitrariness of differentials that must be submitted by the lessee and agreed to by the MMS for each field, and that these differentials would need to be constantly changing to reflect the dynamics of the marketplace.

B. Gravity-price adjustments inadequately explain value differences

Although the methodology to be used for quality and location differentials is not clearly specified in these proposed rules, earlier versions have indicated that a gravity-price adjustment based on posted price schedules and/or pipeline gravity bank parameters would be appropriate.[3] However, the type of gravity-price adjustments suggested by the MMS cannot be used to reconcile the differences in the market value between ANS and California crude oils.

Currently, several companies including Chevron, Union/Tosco, ExxonMobil, Texaco/Equiva, Koch, and Enron (EOTT) publish posted price schedules for California fields. Prices are published independently for crude oils that the posting companies purchase or expect to purchase. The bulletins list crude oil fields, API gravity, and prices per barrel. Different gravity-price adjustments are listed for different gravity ranges. Typically the adjustments for heavy crude oils are greater than for lighter crude oils. Crude oils with API gravity greater than 40° usually have no price adjustment at all.

It is easy to misunderstand the meaning of the gravity-price adjustment. Although the API gravity of California crude oils varies considerably from field to field, production from individual leases is usually quite consistent. There are a few exceptions, but as a general rule if the source of the crude oil is known, its gravity will fall within a predictably narrow range. In instances where gravity does vary within a field from one lease to another, posted price bulletins often contain two different levels of API gravity and two different prices for the same field. For example, Mobil posts a price for 13° South Belridge (for oil under 28°) and 31° South Belridge (for oil above 28°).

Prices actually paid for the various crude oils are adjusted in accordance with gravity variation as per the published scale. These price adjustments are, however, only intended to be applied to variations in gravity for the same crude oil. They are not intended for use in adjusting or comparing prices from one field to another. This is because the sulfur

[3] The Orders to Pay issued by the MMS to various companies for alleged underpayment of royalties on federal leases in California have also applied a simple gravity-price adjustment between California crude oil and ANS as a method of calculating quality differentials.

content, location and other important determinants of value vary significantly from field to field. API gravity is a reasonable predictor of crude oil quality within a field, but not across fields. The posting bulletins themselves can be used to demonstrate the difficulties inherent in the use of gravity adjustments between fields to derive prices. For example, the Wilmington field and the Long Beach (Signal Hill) field are located in the Los Angeles Basin, adjacent to each other. In the Tosco posting bulletin for September 3, 1998, there is a $2.40 difference in the price of oil from these two fields, of which only $1.80 can be accounted for with a simple gravity-price adjustment. This leaves $0.60 that must reflect other quality differences. The specifics of this example and others are shown in Appendix C.

Another way to demonstrate the dissimilarity of ANS and California crude oils is to view observed price differences *as if* they reflected a gravity-price differential. A good way to do that is to return to the earlier example comparing the price of ANS to Line 63, the California crude oil most similar in terms of gravity, sulfur and location. If the market considered ANS and Line 63 to be close substitutes, then the difference in spot prices would be expected to reflect the slight differences in gravity between the two oils. Thus, one could impute a gravity-price differential based on monthly price differences. Figure B-7 compares the results of this calculation with the gravity price differential contained in Chevron posting bulletins during the 1990s. The imputed gravity-price differential derived from the spot price series for ANS and Line 63 gyrates wildly from month to month.

Using ANS as an index for pricing California crude oils involves adjustments that attempt to equate oils not from the same field, or even nearby or similar fields, but rather to oil from an entirely separate oil province.[4] Such comparisons are clearly problematic. As has been shown, even in the simplest case, ANS spot prices do not offer a reliable index for valuing California crude oils. The relationships among market determined prices are much more complex than the proposed rules would suggest.

C. Sulfur and Other Quality Differentials

The price comparisons in Section III demonstrate the difficulties in comparing ANS spot prices and spot price series for California crude oil.

[4] In the United States, California, the Gulf Coast and Alaska's North Slope, are often referred to as distinctly separate geological provinces. Within each province there may be multiple basins. Production within each basin or province is sometimes referred to as crude oil family and may have some common characteristics, even though individual fields can still be quite different. Fields and areas as defined by geologists and as understood in the oil industry are smaller demarcations than are basins, districts and provinces.

However, these comparisons do not address the need to adjust for other quality issues that influence the value of the oil. The four series used are for oils that are fairly similar in terms of sulfur content. The Reuters price series sets the sulfur percentages as follows: ANS (1.1% sulfur), Line 63 (1%), Wilmington (1.5%), and Kern River (1.2%). As noted earlier, the range of sulfur in California is wide, with Outer Continental Shelf oil and the Santa Maria Valley having particularly high concentrations of sulfur. There is little if any market-based information on the discounts specifically associated with sulfur content. Although certain pipeline gravity banks may contain some adjustment standards, these adjustment mechanisms are valid only for small differences. Pipeline users are restricted in the range of sulfur that is allowed, with high sulfur and high viscosity oil accepted for shipment only in batch mode. Shippers are not allowed to put in high sulfur oil and extract lower sulfur grade simply by paying a sulfur penalty. Since no spot prices are collected for high sulfur California crude oils, there is no obvious adjustment that can be translated into a sulfur differential for oil from offshore federal leases not transferred at arm's length. Similarly, information to objectively calculate the market-based differential based on heavy metals or nitrogen content of the wide variety of California crude oils is unavailable.

D. Industry Practice in Valuing California Crude Oil

Clearly, the MMS wishes to move away from the heavy emphasis placed on posted prices encompassed in the 1988 rules for establishing royalty value. And, yet, postings contain unique information about the relative values of crude oil. Even the MMS's consultants have indicated that postings are an accurate reflection of the distinct quality and location differences from one field to another. In their report to the MMS, they stated that: "While the absolute level of California posted prices does not reflect market value, differences in posted prices approximate quality and location differences between crudes. The use of posted prices to establish quality and location differentials between crudes is supported by their use in exchange transactions."[5] The MMS proposed rules would replace that information with a system in which these differentials would be developed administratively by the lessees in negotiations with the MMS or by adjustments determined through regulation.

The rationale for substituting spot prices for postings as a determinant of value for non-arm's length sales further states that "Today, spot prices are readily available to industry participants via price reporting services, and

[5] "California Crude Values Study," prepared for Minerals Management Service by Micronomics, Inc. November 1995, p. 11.

these and similar prices play a significant role in crude oil marketing in terms of the basis upon which deals are negotiated and priced."[6] Whereas, this statement may be correct as a generalization, it is not accurate with respect to the valuation of California crude oils. Although three spot price series are published for California crude oils, these series are for oils that do not cover the full range and variety of crude oil necessary to value oil from federal leases in California. ANS spot prices are available, but as has been demonstrated here, ANS is not similar to the majority of California oil in quality, location or market valuation. Appendix D summarizes the published spot prices of California crude oils and the methodology used in the collection of these prices.

If, indeed, it were possible to make appropriate market-based quality, location and transportation adjustments to the ANS spot price to reflect the differences with each field's oil production, then ANS could serve as an index for valuation. This is however simply a tautology. With appropriate adjustments, anything could serve as an index. The crux of the matter is how and what those adjustments would be, and the likelihood of being able to develop them fairly and efficiently. In our review of transactions data and industry practice, we find no indication that term contracts for the sale or purchase of California crude oil are routinely based on ANS spot prices. Contracts for purchase or sale of ANS are often based on ANS spot prices, but this is hardly the same thing. Since there is no systematic relationship between spot prices (or posted prices) for California oil and ANS, ANS cannot easily serve as an index. If ANS were the index and if the adjustment differentials were intended to reflect market realities, then these differentials would be exceedingly complex, constantly changing, and perhaps, endlessly controversial.

VII. Market Value

The market value of a commodity is nothing more or less than what it will sell for in an open market. The best way to measure market value is to observe prices in actual transactions. This has been a guiding principal of royalty valuation for decades and it should not be abandoned. Systems that attempt to administer prices or anticipate market outcomes, even for the simplest of commodities, invariably collapse.

Crude oil is not a simple commodity. The *Oil and Gas Journal* lists 33,179 separate crude oil fields in the United States. Conceivably, oil from each of these fields has its own peculiar refining qualities and transportation

[6] 64 Fed. Reg. 73821 (December 30, 1999).

options. Determining prices for these fields is no simple matter, but it is something the market has done for over a century. Unfortunately, the MMS has rejected the industry's proposed "comparable sales model" which has the potential to yield reasonably accurate prices for production not sold at arm's length.

The MMS's latest proposal has not simplified the problem of determining the royalty value of various crude oils; it has made it more complex. Information on market-based quality and location differentials would be even more difficult to collect and verify than actual transactions prices from comparable sales. The MMS would be left with two basic approaches. First, they could base royalty values on index prices with adjustments for location and quality negotiated with each of the royalty producers. This would almost certainly result in different valuations for different producers, by definition deviating from the concept of basing royalties on market value. Alternatively, the MMS could proceed with a utility-style cost build-up of transportation and quality differentials, to be subtracted from or added to index prices. As demonstrated, however, such a regulatory approach could result in royalty valuations of California crude oils that are significantly different than their market values. It is also worth adding that if the MMS's proposal is unworkable in California it is likely to be just as arbitrary everywhere else. Despite the superficial appeal, price indexes are simply unsuitable for determining royalty values for the multitude of individual crude oil fields in which the federal government has an interest.

APPENDIX CONTENTS

Appendix A

Samuel A. Van Vactor

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Professional Experience

President, Consulting Economist, Economic Insight, Inc. (EII), Portland, Oregon, 1981 to present, and Researcher at the University of Cambridge, UK.
EII publishes the *Energy Market Report* on the electric power market and provides economic consulting services. The firm averages about ten employees. It collects and organizes economic data, conducts research, undertakes policy analysis and provides expert witness services for anti-trust, tax and regulatory hearings. Recent projects have included analysis of crude oil royalty obligations in the United States for Texaco, Unocal and Exxon; analysis of natural gas market developments in Asia for the Asia Pipeline Research Society of Japan; testimony on behalf of the California Power Exchange before the Federal Energy Regulatory Commission (FERC); and analysis for the California Power Exchange on bilateral power trading, the structure of the Western Power Market, and the development of the exchange's new products and services.

Research Associate, Portland State University, October 1979 to December 1981.
Mr. Van Vactor taught two courses in energy economics and managed several federal grants related to energy and economic issues in the Pacific Northwest.

Director of Planning, Oregon Department of Energy, **October 1978 to October 1979.**
Mr. Van Vactor managed a group of six engineers and economists evaluating energy policy options for the State of Oregon.

Senior Economist, International Energy Agency (IEA) of the OECD, **Paris, France, October 1975 to October 1978.**
Mr. Van Vactor helped design and implement the agency's country studies program.

International Economist, U.S. Treasury Department, **August 1973 to October 1975.**
Mr. Van Vactor was a policy analyst for the Secretary of the Treasury, and advised him on issues related to oil pricing and energy demand. Mr. Van Vactor also assisted in the development of a series of domestic energy policy documents, and was a member of the negotiating team for long-term energy cooperation between the U.S. and other industrialized countries.

Education

Ph.D. Candidate, **Cambridge University, U.K.**
Research, **London School of Economics, U.K.**
M.A., Economics, **University of Washington, U.S.A.**
B.S., Economics, **University of Oregon, U.S.A.**

Significant Publications

I. Contributions were made to the following government publications and reports, including primary authorship of some:

Energy Conservation in the International Energy Agency, 1976 Review, *OECD, Paris, September 1976.*

World Energy Outlook, OECD, Paris, 1977.

Energy Policies and Programs of IEA Countries, 1977 and 1978 Reviews OECD, Paris

Oregon's Energy Future, January 1979.

"Oil Shortages," Oregon Department of Energy, May 1979.

The United States Exerts Limited Influence on the International Crude Oil Spot Market, Report to the Congress by the Comptroller General, US General Accounting Office, August 21, 1980.

Gasoline Demand in the Pacific Northwest, *The Pacific Northwest Supply System* and *Petroleum in the Pacific Northwest: Disruption or Transition*, NW Energy Policy Workshop, 1980.

Alaska's Long-Term Energy Plan, Division of Energy Power and Development, Alaska Department of Commerce, April 1981.

An Energy Emergency Contingency Plan for Alaska, Division of Energy Power and Development, Alaskan Department of Commerce, September 1981.

Fuel Prices in the Northwest, Long-term oil and gas price Forecast for the Northwest Power Planning Council, September 1982.

II. Author or co-author for the following books, articles and speeches:

Competition in the Oil Industry, (NSF funded project at George Washington University,) January 1976, with William A. Johnson and Richard E. Messick.

"Energy Conservation in the OECD, Progress and Results," *The Journal of Energy and Development*, Spring 1978 and International Comparisons of Energy Consumption, Resources for the Future, 1978.

"OPEC in Crisis," a paper delivered at the November 1982 annual meeting of the International Association of Energy Economists.

"World Oil Markets," a paper delivered at the January 1984 annual meeting of the International Association of Energy Economists, with Arlon R. Tussing.

"Mergers and Acquisitions in the Petroleum Industry," published in Papers and Proceedings of the Eighth Annual North American Conference, IAEE, at MIT, November 1986.

"Retrospective on Oil Prices," a paper for delivery at the Western Economic Association Meeting, July 1986 and published in *Contemporary Policy Issues*, July 1987 with Arlon R. Tussing.

"Evolution of Bulk-Power Markets," A paper for delivery at the International Association of Energy Economists, Annual Meeting, Calgary Alberta, July 1987.

"U.S./Canada Trade and Energy: Learning from Past Mistakes," *Forces*, Winter 1988 with Arlon R. Tussing.

"The International Oil Market in 1988," Presentation to The Conference Board of Canada's Business Outlook 1988 Conference, Calgary Alberta, May 1988.

"Is an Oil Tariff Justified? An American Debate: I. Reality Says No," *The Energy Journal*, July 1988 with Arlon R. Tussing.

"Spot and Contract Markets in the Petroleum Industry," with Ronald D. Ripple, a paper delivered at the International Association of Energy Economics, Annual Meeting, Caracas, June 1989.

"Prospective on World Energy Markets: Real Costs Will Continue to Fall," published in the *OPEC Review*, Summer 1990 with Arlon R. Tussing.

PADD V in Transition: Strategic Evaluation of Oil Industry Prospects in the 1990s, November, 1992 published with Energy Security Analysis, Inc.

"Time to End the Alaska Oil Export Ban," published by the Cato Institute, May 1995.

"Natural Gas Deregulation in South Africa: A Wolf in Sheep's Clothing," 1995-1996 with William A. Johnson. Presentation May 1996, Budapest Hungary, International Conference of the IAEE.

"Power Trading: The Race is On," April 1996, with Dona K. Lehr. Speeches in San Diego for Executive Enterprises, Denver for Infocast, and Washington DC and Los Angeles for the IAEE.

"The Demand for Gas in a Coal-Based Energy Economy." with Ronald D. Ripple. Paper for the Northeast Asian Natural Gas Pipeline: Possibilities and Prospects, Beijing, China, September 1996.

"Evolution of Wholesale Power Price Structures in the Western Power Market," with Dona K. Lehr. in *The Evolving U.S. Power Market*, Risk Publications, June 1997.

"Commoditisation" in *The Evolving U.S. Power Market*, Risk Publications, June 1997.

"Natural Gas Projects in Asia and the Development of Asian Gas Trunk Pipelines," for the Financial Times Conference on Asian Gas, June 5-6 1997, Singapore, with Arlon R. Tussing.

“South Korea’s Thirst of Gas,” with Arlon Tussing, *Financial Times Energy Economist*, March 1998.

“Enhancing Private Investment in the Natural Gas Industry in Asia,” in *Natural Gas in Asia: Facts and Fiction*, for PECC Energy Forum, November, 1998.

“Power Exchanges,” Presentation and analysis for the Electric Power Research Institute’s Senior Executive Management Roundtable, November 2, 1998.

“Electricity Restructuring in North America,” *Financial Times Energy Economist*, December, 1998.

Appendix B

Supporting Tables and Graphs

Table B-1
Comparison of Reuters Spot Prices: ANS and Line 63 Crude Oil

Date	West Coast ANS at 29° API ($/bbl.) [1]	Line 63 at 28° API ($/bbl.) [2]	Gravity Adjustment, 20-33° API ($/deg. API)[A] [3]	Line 63 Adjusted to 29° API ($/bbl.) [4] = [2]-1*[3]	Difference ANS - Line 63 at 29° API ($/bbl.) [5]=[1]-[4]
Jul-90	$15.52	$14.81	$0.20	$15.00	$0.51
Aug-90	$26.01	$25.44	$0.29	$25.73	$0.28
Sep-90	$31.95	$31.84	$0.30	$32.14	-$0.19
Oct-90	$31.59	$30.92	$0.32	$31.23	$0.35
Nov-90	$28.72	$27.89	$0.25	$28.14	$0.58
Dec-90	$23.71	$22.98	$0.34	$23.32	$0.39
Jan-91	$20.74	$20.25	$0.23	$20.48	$0.26
Feb-91	$15.70	$15.53	$0.25	$15.78	-$0.08
Mar-91	$16.99	$16.63	$0.25	$16.88	$0.11
Apr-91	$17.58	$16.89	$0.25	$17.14	$0.43
May-91	$16.73	$16.29	$0.25	$16.54	$0.19
Jun-91	$16.29	$15.88	$0.21	$16.09	$0.19
Jul-91	$17.33	$16.47	$0.20	$16.67	$0.66
Aug-91	$17.18	$16.22	$0.25	$16.47	$0.71
Sep-91	$17.35	$16.45	$0.25	$16.70	$0.65
Oct-91	$18.54	$17.67	$0.27	$17.95	$0.59
Nov-91	$17.46	$16.52	$0.25	$16.77	$0.70
Dec-91	$14.88	$13.59	$0.15	$13.74	$1.14
Jan-92	$14.94	$13.09	$0.15	$13.24	$1.69
Feb-92	$15.33	$13.14	$0.15	$13.29	$2.04
Mar-92	$15.49	$13.08	$0.15	$13.23	$2.26
Apr-92	$16.97	$14.71	$0.15	$14.86	$2.11
May-92	$18.09	$16.85	$0.15	$17.00	$1.09
Jun-92	$20.23	$19.35	$0.15	$19.50	$0.73
Jul-92	$19.42	$18.69	$0.15	$18.84	$0.57
Aug-92	$18.00	$17.05	$0.15	$17.20	$0.80
Sep-92	$18.48	$17.58	$0.15	$17.73	$0.74
Oct-92	$18.80	$17.35	$0.15	$17.51	$1.29
Nov-92	$17.42	$15.69	$0.19	$15.88	$1.54
Dec-92	$16.37	$14.51	$0.15	$14.66	$1.71
Jan-93	$15.59	$13.98	$0.15	$14.13	$1.46
Feb-93	$16.81	$15.30	$0.15	$15.45	$1.36
Mar-93	$17.38	$16.12	$0.15	$16.27	$1.11
Apr-93	$18.22	$17.26	$0.15	$17.41	$0.81
May-93	$17.46	$17.12	$0.15	$17.27	$0.19
Jun-93	$16.04	$15.75	$0.15	$15.90	$0.14
Jul-93	$14.79	$13.95	$0.15	$14.10	$0.69
Aug-93	$15.44	$14.48	$0.15	$14.63	$0.81
Sep-93	$15.01	$14.13	$0.15	$14.28	$0.73
Oct-93	$15.45	$14.60	$0.15	$14.75	$0.70
Nov-93	$13.02	$12.24	$0.15	$12.39	$0.63
Dec-93	$10.39	$9.98	$0.15	$10.13	$0.26
Jan-94	$11.64	$11.36	$0.15	$11.51	$0.13
Feb-94	$12.56	$12.30	$0.15	$12.45	$0.12

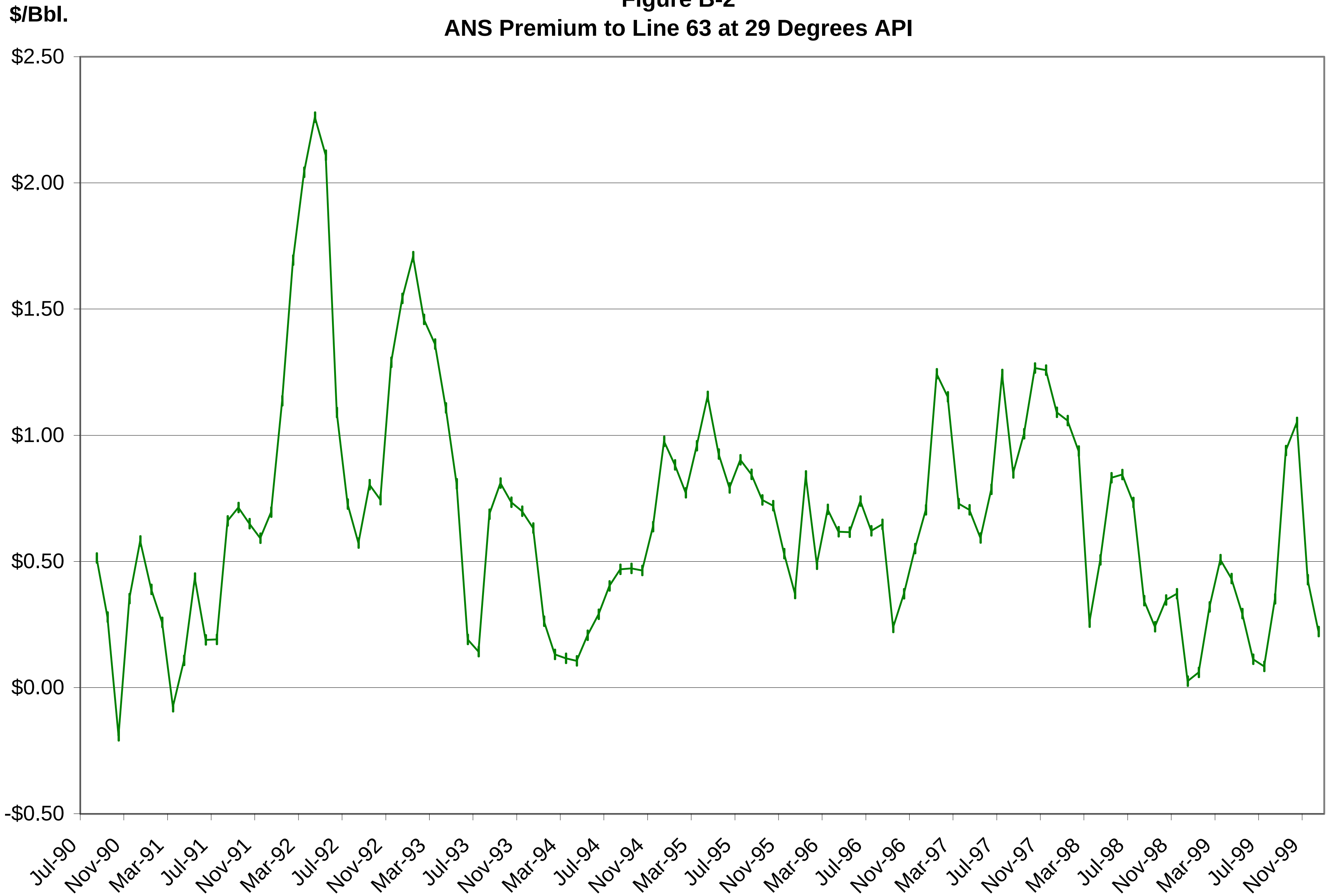
Date	West Coast ANS at 29° API ($/bbl.)	Line 63 at 28° API ($/bbl.)	Gravity Adjustment, 20-33° API ($/deg. API)[A]	Line 63 Adjusted to 29° API ($/bbl.)	Difference ANS - Line 63 at 29° API ($/bbl.)
	[1]	[2]	[3]	[4] = [2]-1*[3]	[5]=[1]-[4]
Mar-94	$12.86	$12.60	$0.15	$12.75	$0.11
Apr-94	$14.91	$14.55	$0.15	$14.70	$0.21
May-94	$16.41	$15.97	$0.15	$16.12	$0.29
Jun-94	$16.46	$15.91	$0.14	$16.05	$0.40
Jul-94	$16.54	$15.94	$0.13	$16.07	$0.47
Aug-94	$16.69	$16.06	$0.15	$16.21	$0.47
Sep-94	$16.11	$15.50	$0.15	$15.65	$0.46
Oct-94	$16.01	$15.22	$0.15	$15.37	$0.64
Nov-94	$16.64	$15.52	$0.15	$15.67	$0.98
Dec-94	$15.50	$14.47	$0.15	$14.62	$0.88
Jan-95	$16.21	$15.29	$0.15	$15.44	$0.77
Feb-95	$17.19	$16.08	$0.15	$16.23	$0.96
Mar-95	$17.29	$15.98	$0.15	$16.13	$1.15
Apr-95	$18.37	$17.34	$0.10	$17.44	$0.93
May-95	$18.37	$17.48	$0.10	$17.58	$0.79
Jun-95	$17.47	$16.47	$0.10	$16.57	$0.90
Jul-95	$16.27	$15.33	$0.10	$15.43	$0.85
Aug-95	$16.70	$15.85	$0.10	$15.95	$0.74
Sep-95	$16.68	$15.86	$0.10	$15.96	$0.72
Oct-95	$15.96	$15.33	$0.10	$15.43	$0.53
Nov-95	$15.89	$15.38	$0.14	$15.52	$0.37
Dec-95	$17.03	$16.04	$0.15	$16.19	$0.84
Jan-96	$17.29	$16.68	$0.12	$16.80	$0.49
Feb-96	$17.83	$17.02	$0.10	$17.12	$0.71
Mar-96	$20.35	$19.63	$0.10	$19.73	$0.62
Apr-96	$22.01	$21.25	$0.15	$21.39	$0.62
May-96	$19.60	$18.66	$0.20	$18.86	$0.74
Jun-96	$18.95	$18.12	$0.20	$18.32	$0.62
Jul-96	$19.74	$18.86	$0.23	$19.09	$0.65
Aug-96	$19.94	$19.45	$0.25	$19.70	$0.24
Sep-96	$21.71	$21.09	$0.25	$21.34	$0.37
Oct-96	$22.58	$21.78	$0.25	$22.03	$0.55
Nov-96	$21.40	$20.49	$0.21	$20.69	$0.70
Dec-96	$23.57	$22.13	$0.20	$22.33	$1.24
Jan-97	$23.62	$22.27	$0.20	$22.47	$1.15
Feb-97	$21.07	$20.10	$0.24	$20.34	$0.73
Mar-97	$20.08	$19.17	$0.21	$19.37	$0.70
Apr-97	$18.48	$17.68	$0.20	$17.88	$0.59
May-97	$19.32	$18.40	$0.13	$18.54	$0.79
Jun-97	$17.26	$15.87	$0.15	$16.02	$1.24
Jul-97	$17.51	$16.51	$0.15	$16.66	$0.85
Aug-97	$18.01	$16.91	$0.10	$17.01	$1.01
Sep-97	$18.12	$16.75	$0.10	$16.85	$1.27
Oct-97	$19.60	$18.24	$0.10	$18.34	$1.26
Nov-97	$18.34	$17.15	$0.10	$17.25	$1.09
Dec-97	$16.43	$15.27	$0.10	$15.37	$1.06
Jan-98	$14.78	$13.73	$0.12	$13.84	$0.94
Feb-98	$13.37	$12.95	$0.16	$13.11	$0.26

Date	West Coast ANS at 29° API ($/bbl.)	Line 63 at 28° API ($/bbl.)	Gravity Adjustment, 20-33° API ($/deg. API)[A]	Line 63 Adjusted to 29° API ($/bbl.)	Difference ANS - Line 63 at 29° API ($/bbl.)
	[1]	[2]	[3]	[4] = [2]-1*[3]	[5]=[1]-[4]
Mar-98	$12.27	$11.59	$0.18	$11.77	$0.51
Apr-98	$12.53	$11.55	$0.15	$11.70	$0.83
May-98	$12.33	$11.34	$0.15	$11.49	$0.84
Jun-98	$11.67	$10.79	$0.15	$10.94	$0.73
Jul-98	$13.02	$12.53	$0.15	$12.68	$0.34
Aug-98	$12.55	$12.16	$0.15	$12.31	$0.24
Sep-98	$14.19	$13.69	$0.15	$13.84	$0.35
Oct-98	$13.42	$12.90	$0.15	$13.05	$0.37
Nov-98	$11.51	$11.34	$0.15	$11.49	$0.03
Dec-98	$9.36	$9.20	$0.10	$9.30	$0.06
Jan-99	$10.78	$10.36	$0.10	$10.46	$0.32
Feb-99	$10.47	$9.86	$0.10	$9.96	$0.51
Mar-99	$13.08	$12.52	$0.12	$12.65	$0.43
Apr-99	$15.61	$15.17	$0.15	$15.32	$0.29
May-99	$15.83	$15.57	$0.15	$15.72	$0.11
Jun-99	$15.92	$15.69	$0.15	$15.84	$0.08
Jul-99	$18.36	$17.85	$0.15	$18.00	$0.35
Aug-99	$20.20	$19.07	$0.19	$19.26	$0.94
Sep-99	$22.90	$21.65	$0.20	$21.85	$1.05
Oct-99	$21.84	$21.21	$0.20	$21.41	$0.43
Nov-99	$23.61	$23.19	$0.20	$23.39	$0.22
Dec-99	$24.53	$24.03	$0.20	$24.23	$0.30
Average	$17.39	$16.54	$0.17	$16.71	
				mean difference	$0.68
				min difference	-$0.19
				max difference	$2.26
				std dev difference	$0.45

Sources: [1],[2]: Reuters
[3]: Chevron Posted Price Bulletins

Notes: A: When multiple gravity adjustments are given in a month, a daily weighted average adjustment is computed.
-Monthly prices are a simple average of daily average prices. Line 63 spot price published at 28°, is "adjusted" to 29° (the gravity at which Reuters publishes its spot price for ANS) using the gravity price differential from Chevron posting bulletins.

Figure B-2
ANS Premium to Line 63 at 29 Degrees API



Economic Insight, Inc.

Table B-3

Comparison of Reuters Spot Prices: ANS and Wilmington Crude Oil

Date	West Coast ANS at 29° API ($/bbl.)	Wilmington at 17° API ($/bbl.)	Gravity Adjustment 0-19° API ($/deg. API)[A]	Gravity Adjustment 20-33°API ($/deg. API)[A]	Wilmington Adjusted to 29° API ($/bbl.)	Difference ANS - Wilm. at 29° API ($/bbl.)
	[1]	[2]	[3]	[4]	[5] = [2]+3*[3]+9*[4]	[6]=[1]-[5]
Jul-90	$15.52	$11.01	$0.20	$0.20	$13.39	$2.13
Aug-90	$26.01	$22.17	$0.29	$0.29	$25.67	$0.33
Sep-90	$31.95	$25.37	$0.30	$0.30	$28.93	$3.02
Oct-90	$31.59	$27.14	$0.32	$0.32	$30.95	$0.64
Nov-90	$28.72	$24.13	$0.25	$0.25	$27.13	$1.59
Dec-90	$23.71	$19.21	$0.34	$0.34	$23.34	$0.37
Jan-91	$20.74	$16.97	$0.23	$0.23	$19.76	$0.99
Feb-91	$15.70	$13.38	$0.25	$0.25	$16.38	-$0.68
Mar-91	$16.99	$12.65	$0.25	$0.25	$15.65	$1.34
Apr-91	$17.58	$13.73	$0.25	$0.25	$16.73	$0.85
May-91	$16.73	$14.35	$0.25	$0.25	$17.35	-$0.61
Jun-91	$16.29	$14.30	$0.21	$0.21	$16.82	-$0.54
Jul-91	$17.33	$14.21	$0.20	$0.20	$16.65	$0.69
Aug-91	$17.18	$14.05	$0.25	$0.25	$17.05	$0.14
Sep-91	$17.35	$14.04	$0.25	$0.25	$17.04	$0.32
Oct-91	$18.54	$14.35	$0.27	$0.27	$17.64	$0.90
Nov-91	$17.46	$14.42	$0.25	$0.25	$17.42	$0.05
Dec-91	$14.88	$12.76	$0.15	$0.15	$14.56	$0.32
Jan-92	$14.94	$11.28	$0.15	$0.15	$13.08	$1.86
Feb-92	$15.33	$11.13	$0.15	$0.15	$12.93	$2.40
Mar-92	$15.49	$11.10	$0.15	$0.15	$12.90	$2.59
Apr-92	$16.97	$12.20	$0.15	$0.15	$14.00	$2.97
May-92	$18.09	$14.37	$0.15	$0.15	$16.17	$1.92
Jun-92	$20.23	$16.92	$0.15	$0.15	$18.72	$1.51
Jul-92	$19.42	$17.54	$0.15	$0.15	$19.34	$0.07
Aug-92	$18.00	$16.13	$0.15	$0.15	$17.93	$0.07
Sep-92	$18.48	$15.64	$0.15	$0.15	$17.44	$1.04
Oct-92	$18.80	$15.45	$0.15	$0.15	$17.29	$1.51
Nov-92	$17.42	$14.26	$0.19	$0.19	$16.54	$0.88
Dec-92	$16.37	$13.12	$0.15	$0.15	$14.92	$1.45
Jan-93	$15.59	$12.54	$0.15	$0.15	$14.34	$1.25
Feb-93	$16.81	$12.90	$0.15	$0.15	$14.70	$2.11
Mar-93	$17.38	$13.74	$0.15	$0.15	$15.54	$1.84
Apr-93	$18.22	$14.46	$0.15	$0.15	$16.26	$1.96
May-93	$17.46	$15.34	$0.15	$0.15	$17.14	$0.32
Jun-93	$16.04	$14.70	$0.15	$0.15	$16.50	-$0.46
Jul-93	$14.79	$12.37	$0.15	$0.15	$14.17	$0.62
Aug-93	$15.44	$12.25	$0.15	$0.15	$14.05	$1.40
Sep-93	$15.01	$12.10	$0.15	$0.15	$13.90	$1.11
Oct-93	$15.45	$12.60	$0.15	$0.15	$14.40	$1.04
Nov-93	$13.02	$11.42	$0.15	$0.15	$13.22	-$0.20
Dec-93	$10.39	$9.16	$0.15	$0.15	$10.96	-$0.56
Jan-94	$11.64	$9.18	$0.15	$0.15	$10.98	$0.67
Feb-94	$12.56	$9.86	$0.15	$0.15	$11.66	$0.90
Mar-94	$12.86	$10.45	$0.15	$0.15	$12.25	$0.61
Apr-94	$14.91	$11.58	$0.15	$0.15	$13.38	$1.53
May-94	$16.41	$13.16	$0.15	$0.15	$14.96	$1.46
Jun-94	$16.46	$14.22	$0.14	$0.14	$15.92	$0.53
Jul-94	$16.54	$14.50	$0.13	$0.13	$16.07	$0.47
Aug-94	$16.69	$15.01	$0.15	$0.15	$16.81	-$0.13
Sep-94	$16.11	$14.57	$0.15	$0.15	$16.37	-$0.26

Date	West Coast ANS at 29° API ($/bbl.)	Wilmington at 17° API ($/bbl.)	Gravity Adjustment 0-19° API ($/deg. API)[A]	Gravity Adjustment 20-33°API ($/deg. API)[A]	Wilmington Adjusted to 29° API ($/bbl.)	Difference ANS - Wilm. at 29° API ($/bbl.)
	[1]	[2]	[3]	[4]	[5] = [2]+3*[3]+9*[4]	[6]=[1]-[5]
Oct-94	$16.01	$14.44	$0.15	$0.15	$16.24	-$0.23
Nov-94	$16.64	$14.17	$0.15	$0.15	$15.97	$0.67
Dec-94	$15.50	$13.82	$0.15	$0.15	$15.62	-$0.12
Jan-95	$16.21	$13.93	$0.15	$0.15	$15.73	$0.48
Feb-95	$17.19	$14.31	$0.15	$0.15	$16.11	$1.08
Mar-95	$17.29	$14.30	$0.15	$0.15	$16.08	$1.21
Apr-95	$18.37	$15.39	$0.10	$0.10	$16.59	$1.78
May-95	$18.37	$16.29	$0.10	$0.10	$17.49	$0.87
Jun-95	$17.47	$15.86	$0.10	$0.10	$17.06	$0.41
Jul-95	$16.27	$14.47	$0.10	$0.10	$15.67	$0.60
Aug-95	$16.70	$14.46	$0.10	$0.10	$15.66	$1.03
Sep-95	$16.68	$14.79	$0.10	$0.10	$15.99	$0.69
Oct-95	$15.96	$14.04	$0.10	$0.10	$15.24	$0.71
Nov-95	$15.89	$13.75	$0.14	$0.14	$15.39	$0.50
Dec-95	$17.03	$14.20	$0.15	$0.15	$16.00	$1.03
Jan-96	$17.29	$15.22	$0.12	$0.12	$16.69	$0.60
Feb-96	$17.83	$15.41	$0.10	$0.10	$16.61	$1.22
Mar-96	$20.35	$17.63	$0.10	$0.10	$18.83	$1.52
Apr-96	$22.01	$19.24	$0.15	$0.15	$20.98	$1.03
May-96	$19.60	$16.02	$0.20	$0.20	$18.42	$1.17
Jun-96	$18.95	$15.27	$0.20	$0.20	$17.67	$1.28
Jul-96	$19.74	$15.67	$0.23	$0.23	$18.40	$1.34
Aug-96	$19.94	$15.81	$0.25	$0.25	$18.81	$1.13
Sep-96	$21.71	$17.36	$0.25	$0.25	$20.36	$1.35
Oct-96	$22.58	$18.61	$0.25	$0.25	$21.61	$0.97
Nov-96	$21.40	$18.05	$0.21	$0.21	$20.53	$0.86
Dec-96	$23.57	$19.71	$0.20	$0.20	$22.11	$1.46
Jan-97	$23.62	$20.32	$0.20	$0.20	$22.72	$0.90
Feb-97	$21.07	$17.62	$0.24	$0.24	$20.49	$0.58
Mar-97	$20.08	$16.72	$0.21	$0.21	$19.24	$0.84
Apr-97	$18.48	$16.11	$0.20	$0.20	$18.51	-$0.04
May-97	$19.32	$16.51	$0.13	$0.13	$18.12	$1.20
Jun-97	$17.26	$15.22	$0.15	$0.15	$17.02	$0.24
Jul-97	$17.51	$14.99	$0.15	$0.15	$16.75	$0.75
Aug-97	$18.01	$15.80	$0.10	$0.10	$17.00	$1.01
Sep-97	$18.12	$15.85	$0.10	$0.10	$17.05	$1.07
Oct-97	$19.60	$16.92	$0.10	$0.10	$18.12	$1.48
Nov-97	$18.34	$15.49	$0.10	$0.10	$16.69	$1.64
Dec-97	$16.43	$13.90	$0.10	$0.10	$15.10	$1.32
Jan-98	$14.78	$11.59	$0.12	$0.12	$13.00	$1.78
Feb-98	$13.37	$10.12	$0.16	$0.16	$12.05	$1.32
Mar-98	$12.27	$9.00	$0.18	$0.18	$11.15	$1.13
Apr-98	$12.53	$9.28	$0.15	$0.15	$11.08	$1.45
May-98	$12.33	$8.94	$0.15	$0.15	$10.74	$1.59
Jun-98	$11.67	$8.18	$0.15	$0.15	$9.98	$1.70
Jul-98	$13.02	$9.34	$0.15	$0.15	$11.14	$1.88
Aug-98	$12.55	$9.44	$0.15	$0.15	$11.24	$1.31
Sep-98	$14.19	$10.59	$0.15	$0.15	$12.39	$1.80
Oct-98	$13.42	$10.65	$0.15	$0.15	$12.45	$0.97
Nov-98	$11.51	$9.52	$0.15	$0.15	$11.30	$0.21
Dec-98	$9.36	$7.26	$0.10	$0.10	$8.46	$0.90
Jan-99	$10.78	$7.85	$0.10	$0.10	$9.05	$1.74
Feb-99	$10.47	$7.83	$0.10	$0.10	$9.03	$1.44
Mar-99	$13.08	$9.37	$0.12	$0.12	$10.86	$2.22

Date	West Coast ANS at 29° API ($/bbl.)	Wilmington at 17° API ($/bbl.)	Gravity Adjustment 0-19° API ($/deg. API)[A]	Gravity Adjustment 20-33°API ($/deg. API)[A]	Wilmington Adjusted to 29° API ($/bbl.)	Difference ANS - Wilm. at 29° API ($/bbl.)
	[1]	**[2]**	**[3]**	**[4]**	**[5] = [2]+3*[3]+9*[4]**	**[6]=[1]-[5]**
Apr-99	$15.61	$11.80	$0.15	$0.15	$13.60	$2.01
May-99	$15.83	$12.69	$0.15	$0.15	$14.49	$1.34
Jun-99	$15.92	$12.26	$0.15	$0.15	$14.06	$1.86
Jul-99	$18.36	$14.36	$0.15	$0.15	$16.16	$2.20
Aug-99	$20.20	$16.19	$0.19	$0.19	$18.49	$1.71
Sep-99	$22.90	$18.89	$0.20	$0.20	$21.29	$1.60
Oct-99	$21.84	$18.77	$0.20	$0.20	$21.17	$0.67
Nov-99	$23.61	$19.85	$0.20	$0.20	$22.25	$1.36
Dec-99	$24.53	$21.15	$0.20	$0.20	$23.55	$0.98
Average	$17.39	$14.35	$0.17	$0.17	$16.36	
					mean difference	$1.03
					min difference	-$0.68
					max difference	$3.02
					std dev difference	$0.74

Sources: [1],[2]: Reuters
[3],[4]: Chevron Posted Price Bulletins

Notes: A: When multiple gravity adjustments are given in a month, a daily weighted average adjustment is computed.

Table B-4
Comparison of Reuters Spot Prices: ANS and Kern River

Date	West Coast ANS at 29° API ($/bbl.)	Kern River at 13° API ($/bbl.)	Gravity Adjustment 0-19° API ($/deg. API)[A]	Gravity Adjustment 20-33° API ($/deg. API)[A]	Kern River Adjusted to 29° API ($/bbl.)	Difference ANS - Kern at 29° API ($/bbl.)
	[1]	[2]	[3]	[4]	[5] = [2]+7*[3]+9*[4]	[6]=[1]-[5]
Jul-90	$15.52	$9.39	$0.20	$0.20	$12.56	$2.96
Aug-90	$26.01	$20.64	$0.29	$0.29	$25.32	$0.69
Sep-90	$31.95	$23.78	$0.30	$0.30	$28.53	$3.42
Oct-90	$31.59	$24.99	$0.32	$0.32	$30.08	$1.51
Nov-90	$28.72	$22.15	$0.25	$0.25	$26.15	$2.57
Dec-90	$23.71	$17.26	$0.34	$0.34	$22.75	$0.96
Jan-91	$20.74	$15.37	$0.23	$0.23	$19.08	$1.66
Feb-91	$15.70	$11.57	$0.25	$0.25	$15.57	$0.13
Mar-91	$16.99	$10.93	$0.25	$0.25	$14.93	$2.06
Apr-91	$17.58	$11.83	$0.25	$0.25	$15.83	$1.75
May-91	$16.73	$12.35	$0.25	$0.25	$16.35	$0.38
Jun-91	$16.29	$12.30	$0.21	$0.21	$15.66	$0.62
Jul-91	$17.33	$12.08	$0.20	$0.20	$15.34	$2.00
Aug-91	$17.18	$12.01	$0.25	$0.25	$16.01	$1.18
Sep-91	$17.35	$11.91	$0.25	$0.25	$15.91	$1.45
Oct-91	$18.54	$12.20	$0.27	$0.27	$16.58	$1.96
Nov-91	$17.46	$12.50	$0.25	$0.25	$16.50	$0.96
Dec-91	$14.88	$10.83	$0.15	$0.15	$13.23	$1.65
Jan-92	$14.94	$9.89	$0.15	$0.15	$12.29	$2.65
Feb-92	$15.33	$9.96	$0.15	$0.15	$12.36	$2.97
Mar-92	$15.49	$9.89	$0.15	$0.15	$12.29	$3.20
Apr-92	$16.97	$11.05	$0.15	$0.15	$13.45	$3.52
May-92	$18.09	$13.25	$0.15	$0.15	$15.65	$2.45
Jun-92	$20.23	$15.66	$0.15	$0.15	$18.06	$2.17
Jul-92	$19.42	$15.99	$0.15	$0.15	$18.39	$1.03
Aug-92	$18.00	$14.75	$0.15	$0.15	$17.15	$0.85
Sep-92	$18.48	$14.28	$0.15	$0.15	$16.68	$1.80
Oct-92	$18.80	$14.11	$0.15	$0.15	$16.57	$2.23
Nov-92	$17.42	$13.02	$0.19	$0.19	$16.06	$1.36
Dec-92	$16.37	$11.94	$0.15	$0.15	$14.34	$2.03
Jan-93	$15.59	$11.43	$0.15	$0.15	$13.83	$1.76
Feb-93	$16.81	$11.78	$0.15	$0.15	$14.18	$2.63
Mar-93	$17.38	$12.41	$0.15	$0.15	$14.81	$2.56
Apr-93	$18.22	$13.10	$0.15	$0.15	$15.50	$2.72
May-93	$17.46	$13.93	$0.15	$0.15	$16.33	$1.13
Jun-93	$16.04	$13.18	$0.15	$0.15	$15.58	$0.46
Jul-93	$14.79	$11.10	$0.15	$0.15	$13.50	$1.29
Aug-93	$15.44	$10.96	$0.15	$0.15	$13.36	$2.08
Sep-93	$15.01	$10.81	$0.15	$0.15	$13.21	$1.80
Oct-93	$15.45	$11.29	$0.15	$0.15	$13.69	$1.76
Nov-93	$13.02	$10.15	$0.15	$0.15	$12.55	$0.48
Dec-93	$10.39	$8.17	$0.15	$0.15	$10.57	-$0.18
Jan-94	$11.64	$8.10	$0.15	$0.15	$10.50	$1.15
Feb-94	$12.56	$8.87	$0.15	$0.15	$11.27	$1.30
Mar-94	$12.86	$9.24	$0.15	$0.15	$11.64	$1.22
Apr-94	$14.91	$10.23	$0.15	$0.15	$12.63	$2.28
May-94	$16.41	$11.70	$0.15	$0.15	$14.10	$2.31
Jun-94	$16.46	$12.92	$0.14	$0.14	$15.18	$1.27
Jul-94	$16.54	$13.28	$0.13	$0.13	$15.37	$1.16
Aug-94	$16.69	$14.06	$0.15	$0.15	$16.46	$0.22

Date	West Coast ANS at 29° API ($/bbl.)	Kern River at 13° API ($/bbl.)	Gravity Adjustment 0-19° API ($/deg. API)[A]	Gravity Adjustment 20-33° API ($/deg. API)[A]	Kern River Adjusted to 29° API ($/bbl.)	Difference ANS - Kern at 29° API ($/bbl.)
	[1]	[2]	[3]	[4]	[5] = [2]+7*[3]+9*[4]	[6]=[1]-[5]
Sep-94	$16.11	$13.56	$0.15	$0.15	$15.96	$0.16
Oct-94	$16.01	$13.06	$0.15	$0.15	$15.46	$0.55
Nov-94	$16.64	$12.82	$0.15	$0.15	$15.22	$1.42
Dec-94	$15.50	$12.41	$0.15	$0.15	$14.81	$0.69
Jan-95	$16.21	$12.47	$0.15	$0.15	$14.87	$1.34
Feb-95	$17.19	$12.94	$0.15	$0.15	$15.34	$1.85
Mar-95	$17.29	$13.35	$0.15	$0.15	$15.72	$1.57
Apr-95	$18.37	$14.48	$0.10	$0.10	$16.08	$2.29
May-95	$18.37	$15.30	$0.10	$0.10	$16.90	$1.47
Jun-95	$17.47	$15.07	$0.10	$0.10	$16.67	$0.80
Jul-95	$16.27	$14.08	$0.10	$0.10	$15.68	$0.59
Aug-95	$16.70	$13.57	$0.10	$0.10	$15.17	$1.53
Sep-95	$16.68	$13.78	$0.10	$0.10	$15.38	$1.30
Oct-95	$15.96	$12.62	$0.10	$0.10	$14.22	$1.74
Nov-95	$15.89	$12.30	$0.14	$0.14	$14.49	$1.40
Dec-95	$17.03	$12.77	$0.15	$0.15	$15.17	$1.86
Jan-96	$17.29	$14.08	$0.12	$0.12	$16.04	$1.24
Feb-96	$17.83	$14.33	$0.10	$0.10	$15.93	$1.90
Mar-96	$20.35	$16.57	$0.10	$0.10	$18.17	$2.18
Apr-96	$22.01	$18.00	$0.15	$0.15	$20.32	$1.68
May-96	$19.60	$14.89	$0.20	$0.20	$18.09	$1.51
Jun-96	$18.95	$14.08	$0.20	$0.20	$17.28	$1.67
Jul-96	$19.74	$13.82	$0.23	$0.23	$17.46	$2.28
Aug-96	$19.94	$13.95	$0.25	$0.25	$17.95	$1.99
Sep-96	$21.71	$15.77	$0.25	$0.25	$19.77	$1.94
Oct-96	$22.58	$17.23	$0.25	$0.25	$21.23	$1.35
Nov-96	$21.40	$16.68	$0.21	$0.21	$19.98	$1.42
Dec-96	$23.57	$18.22	$0.20	$0.20	$21.42	$2.16
Jan-97	$23.62	$18.73	$0.20	$0.20	$21.93	$1.69
Feb-97	$21.07	$14.99	$0.24	$0.24	$18.82	$2.25
Mar-97	$20.08	$14.58	$0.21	$0.21	$17.93	$2.15
Apr-97	$18.48	$14.30	$0.20	$0.20	$17.50	$0.97
May-97	$19.32	$14.68	$0.13	$0.13	$16.82	$2.50
Jun-97	$17.26	$13.64	$0.15	$0.15	$16.04	$1.22
Jul-97	$17.51	$13.59	$0.15	$0.15	$15.93	$1.57
Aug-97	$18.01	$14.59	$0.10	$0.10	$16.19	$1.82
Sep-97	$18.12	$14.80	$0.10	$0.10	$16.40	$1.72
Oct-97	$19.60	$15.96	$0.10	$0.10	$17.56	$2.04
Nov-97	$18.34	$14.31	$0.10	$0.10	$15.91	$2.43
Dec-97	$16.43	$12.65	$0.10	$0.10	$14.25	$2.17
Jan-98	$14.78	$10.32	$0.12	$0.12	$12.21	$2.58
Feb-98	$13.37	$8.47	$0.16	$0.16	$11.04	$2.33
Mar-98	$12.27	$6.90	$0.18	$0.18	$9.76	$2.51
Apr-98	$12.53	$7.65	$0.15	$0.15	$10.05	$2.48
May-98	$12.33	$7.81	$0.15	$0.15	$10.21	$2.12
Jun-98	$11.67	$7.18	$0.15	$0.15	$9.58	$2.09
Jul-98	$13.02	$8.24	$0.15	$0.15	$10.64	$2.38
Aug-98	$12.55	$8.29	$0.15	$0.15	$10.69	$1.86
Sep-98	$14.19	$9.39	$0.15	$0.15	$11.79	$2.40
Oct-98	$13.42	$9.75	$0.15	$0.15	$12.15	$1.27
Nov-98	$11.51	$8.49	$0.15	$0.15	$10.87	$0.64
Dec-98	$9.36	$6.53	$0.10	$0.10	$8.13	$1.23
Jan-99	$10.78	$7.13	$0.10	$0.10	$8.73	$2.05
Feb-99	$10.47	$7.08	$0.10	$0.10	$8.68	$1.79

Date	West Coast ANS at 29° API ($/bbl.)	Kern River at 13° API ($/bbl.)	Gravity Adjustment 0-19° API ($/deg. API)[A]	Gravity Adjustment 20-33° API ($/deg. API)[A]	Kern River Adjusted to 29° API ($/bbl.)	Difference ANS - Kern at 29° API ($/bbl.)
	[1]	[2]	[3]	[4]	[5] = [2]+7*[3]+9*[4]	[6]=[1]-[5]
Mar-99	$13.08	$8.56	$0.12	$0.12	$10.55	$2.53
Apr-99	$15.61	$10.95	$0.15	$0.15	$13.35	$2.26
May-99	$15.83	$11.79	$0.15	$0.15	$14.19	$1.64
Jun-99	$15.92	$11.19	$0.15	$0.15	$13.59	$2.33
Jul-99	$18.36	$13.37	$0.15	$0.15	$15.77	$2.58
Aug-99	$20.20	$15.29	$0.19	$0.19	$18.36	$1.84
Sep-99	$22.90	$17.92	$0.20	$0.20	$21.12	$1.78
Oct-99	$21.84	$17.81	$0.20	$0.20	$21.01	$0.82
Nov-99	$23.61	$18.83	$0.20	$0.20	$22.03	$1.57
Dec-99	$24.53	$20.00	$0.20	$0.20	$23.20	$1.33
Average	$17.39	$13.00	$0.17	$0.17	$15.68	
					mean difference	$1.71
					min difference	-$0.18
					max difference	$3.52
					std dev difference	$0.72

Sources: [1],[2]: Reuters
[3],[4]: Chevron Posted Price Bulletins

Notes: A: When multiple gravity adjustments are given in a month, a daily weighted average adjustment is computed.

Table B-5
Representative Assays for Selected California Crude Oils*

Field	Sample Id.	Gravity ° API	Sulfur % Weight	Distillation Breakdown (Percent of Volume)			
				Total Gasoline & Naptha	Middle Distillates	Residuum	Lubes
San Ardo	53059	12.2	2.25%	2.1%	14.5%	62.5%	20.5%
Midway Sunset	78031	12.6	1.61%	0.0%	12.0%	50.3%	34.8%
Kern River	461	13.3	1.14%	0.0%	15.8%	56.1%	28.1%
Mount Poso	55150	16.0	0.68%	0.0%	13.4%	52.0%	34.0%
Wilmington	77025	17.1	1.66%	9.5%	18.2%	52.8%	19.4%
Lost Hills	1099	18.4	0.99%	7.6%	23.5%	42.7%	23.2%
Huntington Beach	23517	19.4	2.00%	12.0%	19.7%	48.9%	19.4%
Inglewood	43031	21.0	1.84%	12.9%	27.6%	39.1%	19.4%
Long Beach	1138	25.0	1.25%	18.9%	23.1%	40.6%	17.4%
Dos Cuadros	69230	25.0	1.14%	21.0%	21.5%	39.0%	17.9%
Ventura	55128	30.2	1.00%	30.2%	20.8%	31.3%	16.3%
Belridge N. Lt.	46049	31.3	0.28%	25.7%	25.7%	26.3%	20.9%
Elk Hills	80006	34.6	0.76%	34.3%	23.3%	25.0%	15.9%

* These assays were selected from assay data from the DOE Laboratory in Bartlesville, Oklahoma. Some of these data

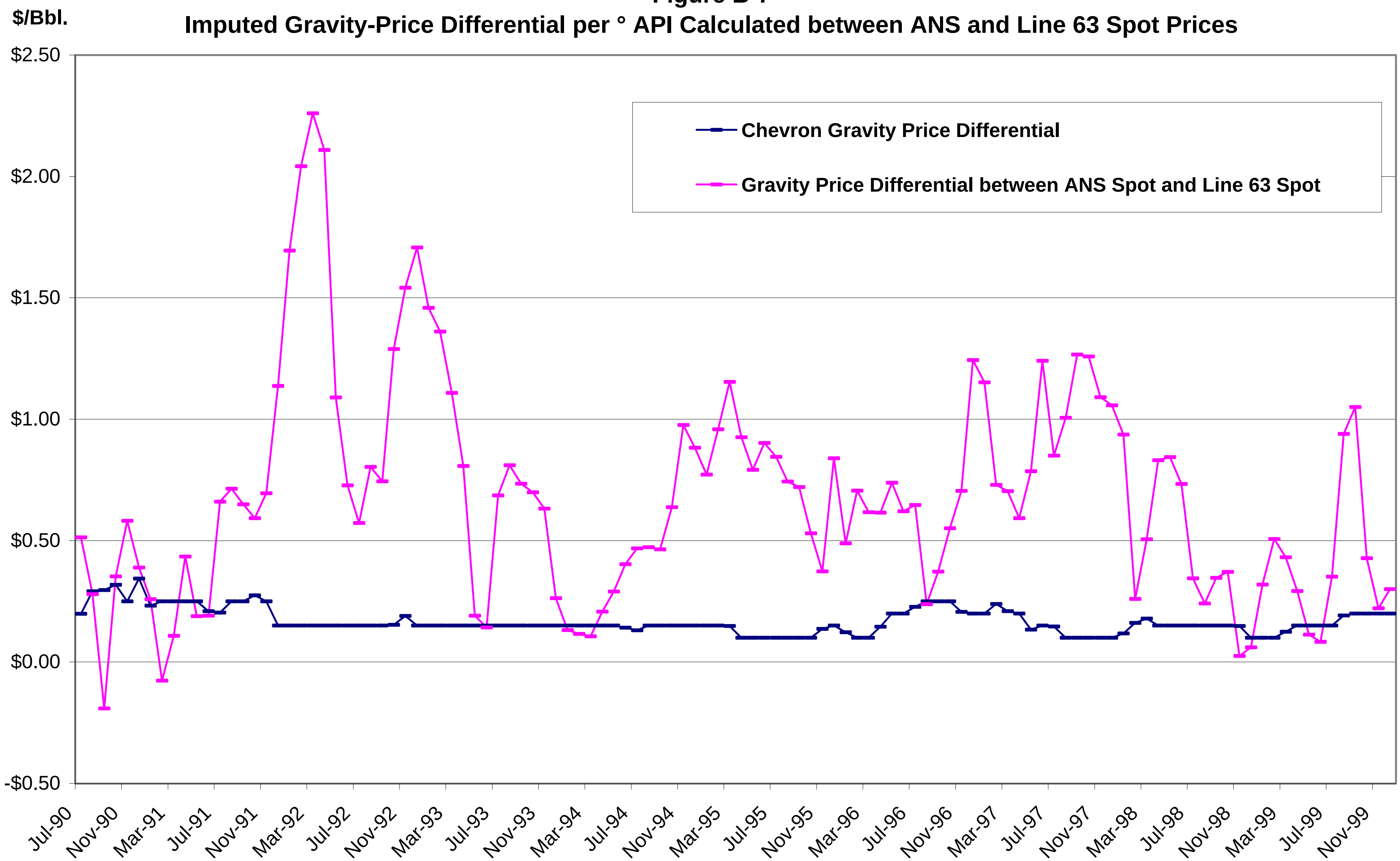
the assay was in general representative of the population of assays for the given field.

Table B-6
Heavy and Light Oil Production for the State of California in the Month of January

	Production in barrels per day		Percentage of State Production	
	Heavy Oil[A] Production *bbl/day*	**Light Oil[B] Production** *bbl/day*	**Heavy Oil Production**	**Light Oil Production**
1990	679,015	292,378	69.9%	30.1%
1991	661,411	287,556	69.7%	30.3%
1992	655,719	294,133	69.0%	31.0%
1993	622,924	302,418	67.3%	32.7%
1994	627,405	296,106	67.9%	32.1%
1995	644,726	308,751	67.6%	32.4%
1996	664,981	286,446	69.9%	30.1%
1997	656,415	255,981	71.9%	28.1%
1998	659,300	274,656	70.6%	29.4%

A: Heavy oil has gravity of 20° API and below.
B: Light oil has gravity of over 20° API.
Source: 1998 Annual Report of the State Oil and Gas Supervisor, California Department of Conservation, Division of Oil, Gas, and Geothermal Resources.

Figure B-7
Imputed Gravity-Price Differential per ° API Calculated between ANS and Line 63 Spot Prices



Source: Reuters (Spot Prices) and Chevron Posted Price Bulletins (Chevron Gravity-Price Differential).
Notes: The Gravity-Price Differential between ANS Spot and Line 63 Spot is calculated as the difference in price between the two spot prices divided by the difference in degrees of API gravity between the two prices to arrive at an Imputed Gravity-Price differential per degree API.

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Attachment to Appendix D
Spot Price Comparison for ANS (Reuters and Platts)

	Reuters West Coast ANS at 29° API ($/bbl.)	Platt's West Coast ANS at 29-29.5° API ($/bbl.)	Difference Reuters Less Platts
	[1]	[2]	[3] = [1] - [2]
Jan-94	$11.64	$11.60	$0.04
Feb-94	$12.56	$12.57	-$0.01
Mar-94	$12.86	$12.91	-$0.05
Apr-94	$14.91	$14.83	$0.08
May-94	$16.41	$16.54	-$0.13
Jun-94	$16.46	$16.47	-$0.02
Jul-94	$16.54	$16.54	$0.00
Aug-94	$16.69	$16.60	$0.09
Sep-94	$16.11	$16.10	$0.01
Oct-94	$16.01	$16.08	-$0.07
Nov-94	$16.64	$16.71	-$0.07
Dec-94	$15.50	$15.38	$0.12
Jan-95	$16.21	$16.16	$0.05
Feb-95	$17.19	$17.14	$0.05
Mar-95	$17.29	$17.32	-$0.03
Apr-95	$18.37	$18.38	-$0.01
May-95	$18.37	$18.35	$0.02
Jun-95	$17.47	$17.44	$0.03
Jul-95	$16.27	$16.25	$0.02
Aug-95	$16.70	$16.72	-$0.02
Sep-95	$16.68	$16.65	$0.03
Oct-95	$15.96	$15.96	$0.00
Nov-95	$15.89	$15.87	$0.02
Dec-95	$17.03	$16.94	$0.09
Jan-96	$17.29	$17.23	$0.06
Feb-96	$17.83	$17.78	$0.05
Mar-96	$20.35	$20.40	-$0.05
Apr-96	$22.01	$22.04	-$0.03
May-96	$19.60	$19.65	-$0.05
Jun-96	$18.95	$18.98	-$0.03
Jul-96	$19.74	$19.74	$0.00
Aug-96	$19.94	$19.97	-$0.03
Sep-96	$21.71	$21.73	-$0.02
Oct-96	$22.58	$22.60	-$0.02
Nov-96	$21.40	$21.50	-$0.10
Dec-96	$23.57	$23.66	-$0.09
Jan-97	$23.62	$23.58	$0.04
Feb-97	$21.07	$21.03	$0.04
Mar-97	$20.08	$20.07	$0.01
Apr-97	$18.48	$18.54	-$0.06
May-97	$19.32	$19.41	-$0.09
Jun-97	$17.26	$17.30	-$0.04
Jul-97	$17.51	$17.48	$0.03
Aug-97	$18.01	$17.98	$0.03

	[1]	[2]	[3] = [1] - [2]
Sep-97	$18.12	$18.09	$0.03
Oct-97	$19.60	$19.59	$0.01
Nov-97	$18.34	$18.33	$0.01
Dec-97	$16.43	$16.39	$0.04
Jan-98	$14.78	$14.79	-$0.01
Feb-98	$13.37	$13.39	-$0.02
Mar-98	$12.27	$12.25	$0.02
Apr-98	$12.53	$12.42	$0.11
May-98	$12.33	$12.31	$0.02
Jun-98	$11.67	$11.62	$0.05
Jul-98	$13.02	$12.92	$0.10
Aug-98	$12.55	$12.49	$0.06
Sep-98	$14.19	$14.13	$0.06
Oct-98	$13.42	$13.38	$0.04
Nov-98	$11.51	$11.47	$0.04
Dec-98	$9.36	$9.39	-$0.03
Jan-99	$10.78	$10.69	$0.09
Feb-99	$10.47	$10.43	$0.04
Mar-99	$13.08	$13.06	$0.02
Apr-99	$15.61	$15.64	-$0.03
May-99	$15.83	$15.86	-$0.03
Jun-99	$15.92	$15.84	$0.08
Jul-99	$18.36	$18.16	$0.20
		Average	$0.01
		Maximum	$0.20
		Minimum	-$0.13
		StdDev	$0.06

Appendix C
Gravity Price Adjustments for Adjacent Fields

The examples listed below are comparisons of crude oil fields not of the same gravity, but located adjacent to one another or within ten miles of one another so that transportation should not be an issue in price differences. Gravity price differentials were applied to see if a gravity price adjustment is able to account for all differences in price. For crude oil prices, gravities, and gravity adjustments, the Tosco/Union posting bulletin for September 3, 1998 was used.

<u>Example 1</u>

Midway Sunset	13°	$ 8.75
Buena Vista	26°	$11.00

Adjusted to 26° / $0.15 for every degree

Midway Sunset	26°	$10.70
Buena Vista	26°	$11.00

Unaccounted for Difference = $0.30

<u>Example 2</u>

Wilmington	17°	$ 9.25
LB (Signal Hill)	29°	$11.65

Adjusted to 29° / $0.15 for every degree

Wilmington	29°	$11.05
LB (Signal Hill)	29°	$11.65

Unaccounted for Difference = $0.60

<u>Example 3</u>

Newhall Potrero	32°	$12.00
Del Valle	33°	$11.45

Adjusted to 33° / $0.15 for every degree

Newhall Potrero	33°	$12.15
Del Valle	33°	$11.45

Unaccounted for Difference = $0.70

Example 4

Yorba Linda	15°	$ 8.75
Brea Olinda	20°	$10.60

Adjusted to 20° / $0.15 for every degree

Yorba Linda	20°	$ 9.50
Brea Olinda	20°	$10.60

Unaccounted for Difference = $1.10

Example 5

Cat Canyon	11°	$ 5.60
Orcutt	25°	$ 8.55

Adjusted to 25° / $0.15 for every degree

Cat Canyon	25°	$ 7.70
Orcutt	25°	$ 8.55

Unaccounted for Difference = $0.85

Appendix D
Sources of Crude Oil Spot Prices

Reuters
Methodology

Reuters prices are collected by a reporter on a daily basis. The Reuters reporter contacts market participants inquiring about current prices and ranges. The data is collected and is published as a daily high and low. The closing price for the crude oils is the mean of the daily high and low.

Reuters provides West Coast crude oil spot price information for the following crude oils:
<u>Line 63</u>, with gravity 28.0 degrees API, and sulfur 1 pct.
<u>ANS delivered to the West Coast</u>, with gravity 29.0 degrees API and sulfur 1.1 pct.
<u>Wilmington</u>, with gravity 17.0 degrees API and sulfur 1.5 pct.
<u>Kern River</u>, with gravity 13.0 degrees API and sulfur 1.2 pct.

Reuters also reports on spot price differentials and spot price in terms of premium to posting:

<u>Line 63 vs. Differential</u>
<u>ANS vs. Last Repeated Bid</u>
<u>Wilmington Premium to Posting</u>
<u>Kern River Premium to posting</u>

Platt's
Methodology

There are general principles that underlie Platt's approach to market reporting. For example, Platt's generally looks for fixed-price spot transactions, confirmed bids and offers, market talk and relationships, if any, with other markets. Platt's reporters also generally look at the characteristics of individual markets and the foregoing methodology may be adapted especially in cases where fixed-price liquidity is lacking.

Platt's prices are published in three daily publications: *Platt's Oilgram News*, *Platt's Oilgram Price Report* and *Platt's Crude Oil Marketwire*. A high and low range of prices is published daily in the *Platt's Crude Oil Marketwire*. Prices are reported in a five-day rolling average format in the *Platt's Oilgram Price Report* (a weekly publication). Also Platt's puts out a monthly crude oil supplement, *Platt's Crude Oil Supplement*, which reports a simple average for the month of the daily low, high and mean prices.

Platt's provides West Coast crude oil spot price information on the following crude oils:
<u>Alaska North Slope (ANS)</u>: California barrels are for delivery to Long Beach, California. API Gravity is 29-29.5 and sulfur content is 1.1 pct.
<u>Line 63</u>: The assessment is for a blend of crude at 28-30 degrees API gravity and sulfur content of 1.02 pct. Delivered at Hynes station on Four Corners' pipeline line 63.

P-Plus Line 63: The assessment reflects the price of Line 63 sold into Hynes Station on Four Corners' pipeline on the basis of "Posting Plus." P-Plus deals are invoiced at a later date on the basis of a differential to an average of one or more crude postings for Buena Vista.
Thums: The assessment is for barrels of Wilmington delivered to Long Beach, California at 17 degrees API and sulfur content of 1.5 pct.
Kern River: The assessment is for barrels delivered commonly to Texaco's station 31 in Kern County, California, at 13.4 degrees API gravity with sulfur content of 1.1 pct. Synonymous with San Joaquin Valley (SJV) heavy.

Telerate Methodology

Spot prices are assessments – subjective by their nature – published under the Telerate Energy banner by Bridge News and by Dow Jones Newswires jointly with Telerate Energy. Assessments are the results of reporters' wide survey of market participants and likely include, depending on market conditions, elements of transactions, bids, offers, "indications," "talking levels," or differentials vs. other active grades. Assessments typically conform to standard calendar periods, quantities and qualities.

Telerate reports on the following spot crude oil prices:
Kern River, This is San Joaquin Valley Heavy crude oil and is typically the spot price for Kern River or Midway Sunset. The gravity is 13 degrees API and the sulfur is 1.0 pct.
Thums, This is typically a spot assessment of Wilmington crude oil at a gravity of 17 degrees API and a sulfur of 1.5 pct.

Line 63 CIF LA, This is a spot assessment of Line 63 crude oil at 28 degrees API and sulfur of 1.0 pct.
ANS CIF LA, This is a spot assessment of ANS crude at a gravity of 29 degrees API and sulfur of 1.1 pct.

Also attached is a table comparing ANS spot prices from Reuters with spot prices from Platt's. The average difference between these two price series is $0.01.