Appraising Oil and Gas Rights in the Pennsylvania Marcellus Shale

In early 2008 Richard J. Miller & Associates, Inc.("RJM&A") was asked to do appraisals of the oil and gas rights owned by three hunting clubs in Lycoming County, Pennsylvania. The oil and gas rights ("the rights") had been leased with the apparent objective of developing natural gas production from the Marcellus Shale. No geophysical surveys had been done, there had been no drilling on the properties or anywhere nearby, and needless to say, no production of gas. After considerable discussion and research, a method for appraising the rights was defined, subjected to review, and applied to the three properties; the method was subsequently applied to many other properties. Since 2008, RJM&A has conducted appraisals of roughly 400 Pennsylvania properties located primarily in Bradford, Lycoming, Sullivan, Susquehanna and Tioga counties.

Appraisals done in 2008-09 were largely of the rights owned by not-for-profit hunting clubs for the purpose of severance of the rights from the surface real estate. Currently the majority of appraisals are being done for individuals and families for gift tax and estate planning purposes. For the most part these are properties where the rights have been leased but there has been no drilling or production. However, as drilling and production activity in the region has increased and the status of development on individual properties has evolved it has become necessary to incorporate those changes into the appraisal of specific properties. Appraisal procedures have to consider more options for the properties and have become more complex.

The properties that have been appraised can be sorted into three broad categories:

- Leased but Undeveloped - The oil and gas rights are leased. Geophysical surveys may have been conducted on the property. There may or may not be any well drilling permit requests submitted or approved for the property.

- Leased and Partially Developed - The property may or may not be included in a pooled unit. There may be drilling permits requested and/or approved; there may be a development plan in place; and there may be one or more wells drilled either on the property, or on a property with which it is pooled, but there is no production.

- Producing - In this case the property, or a pooled unit that includes the property, is producing, there are sales of gas, and the Lessor is receiving royalty income.

Initially, the first category was the most common making up essentially 100% of all appraisals; however, the Leased and Partially Developed category now occurs more frequently while about one-third of appraisals are of producing properties. Each of these categories requires a somewhat different approach. The following discussion reviews generally accepted appraisal practices for oil and gas rights and the approaches that may be taken to appraise properties in each

of the above categories, along with an exposition of some of the misconceptions and errors that arise in attempting to assign value to Marcellus oil and gas rights.

Generally Accepted Appraisal Practice

An appraisal is done to estimate the (fair) market value of a property as of a certain date. All valid and acceptable appraisals occur in the context of basic appraisal methods. Oil and gas rights are considered, in most jurisdictions, to be real property. Generally accepted appraisal practice recognizes three approaches to estimate market value for real property.

The ***Cost Approach*** estimates value based on the cost to replace or reproduce a structure or facility. This method has no application to oil and gas property appraisal since the property cannot be reproduced or replaced by new construction regardless of investment. Each field and property is unique both in time and in terms of the development and operation of the property by the owner(s).

The ***Comparable Sales*** approach, which has wide usage in real estate appraisal, relies upon the comparison of one or more properties that have been sold to the property being appraised. This approach has very little use in the appraisal of oil and gas properties for several reasons. Unlike residential and commercial real estate, there is no common searchable database of transactions from which to draw information. The only information that may be available through publications or hearsay is that a certain property was sold and (sometimes) the estimated purchase price. The appraiser may be able to obtain some information about production, number of wells, oil gravity, and other parameters from public sources but unlike a residential property, where the appraiser can obtain information from a multiple-listing service, there is no such source for oil and gas properties.

Oil and gas properties have most commonly been appraised by the ***Income Approach*** which estimates the value of a future stream of income. This choice results from the recognition that the source of value is the income stream to be received; the concerns regarding the Cost and Comparable Sales methods noted above; and the knowledge that it is the method most commonly employed by investors in and appraisers of oil and gas producing properties. The use of the Income Approach requires that there be sufficient information on which to base a valid and reliable appraisal.

Appraisal of Leased, Undeveloped Properties

The need for appraisal of undeveloped leases in the Marcellus is usually the result of the desire by the owner(s) of the rights to establish a value of the rights for a specific property prior to transfer of the rights. Leased-but-undeveloped oil and gas properties are not commonly appraised unless they can be shown to be part of an existing field or development trend. Even in those circumstances there is a requirement for reliable data regarding offset or nearby production that can be ***directly*** related to the property being appraised. In 2008 there was no reliable information on which to base a value for Marcellus oil and gas rights by the methods commonly used in appraisal practice. There was no reported production and sales of Marcellus gas for use as analogy production, and no reliable published studies of recovery potential that could provide a foundation for production and income estimates for specific properties.

However, the rapid increase in leasing activity clearly indicated that oil and gas rights which had essentially no material value in 2004 did have value in 2008. Where there is a valid lease of the oil and gas rights on a property, the terms of the lease are a reasonable indicator of the value added to the oil and gas rights. The Lessee and Lessor had negotiated an agreement, as of the date of the lease, giving the Lessee access to the property to explore for and develop any oil and/or gas that may be found. That agreement represents a source of value to both parties. The most direct measure of that value is the amount of any bonus payment plus the sum of the delay rentals, extension payments, and any other payment(s) agreed to by both parties as of the effective date of the lease. This *"terms of lease"* approach was applied to virtually all leased undeveloped properties and continues to have application to many properties even as Marcellus gas production has expanded.

As an example, a 1,000 acre property might be encumbered by a lease that includes a bonus of $20.00 per acre and an annual delay rental of $5.00 per acre. Absent any other source of income, at the date of lease signing, the oil and gas rights would have a value of $20,000 (bonus) plus the present value of the future delay rental or about $18,181. If the lease were Paid-Up the value would be $40,000. This approach recognizes that the lease agreement adds value to the property.

Critique of the "Terms of Lease" Approach

There have been criticisms of this approach but none that withstand scrutiny. One opinion suggests that a property subject to a lease agreement that was entered into in 2006 with a small bonus and delay rental of $5.00 per acre should be valued using the current "market" rates for bonus and rentals. Since the dollar amount of bonus payments and delay rentals (and royalty percentages) went up substantially from 2006 through 2010 the argument suggests that the "market" value of the oil and gas rights is much higher in 2010 than it was be in 2006 or 2007.

There is a certain attraction to this argument that is reminiscent of real estate appraisal practice but the analogy is incorrect. An oil and gas lease is a **contract** between the owner of the oil and gas rights (the Lessor) and a party interested in exploiting those rights (the Lessee). Marcellus lease terms commonly included an initial or "primary term" of five years; delay rental payments if a well is not drilled in the first or subsequent years; a royalty of 12.5% up to 20%; and provisions that allows the Lessee to automatically renew or extend the lease, pool or unitize the property with other leases, and use the property for gas storage. Further, the contract is biased toward the Lessee. Unless the Lessor has been careful to edit and amend the standard lease terms, the Lessee often has the right to automatically extend the lease, on the existing terms, usually for another period equal to the primary term. In addition, the Lessee can, depending on the language of the lease, convert the lease to "held by operations" by conducting certain activities on the property. Except in unusual circumstances the Lessor has very few opportunities to alter the terms of the lease and very little recourse to obtain additional income unless and until production starts and royalties are paid.

Another argument suggests that the oil and gas rights of a particular property could be valued using the information from sales of similar interests. This approach would estimate the value of the subject property by deriving values from the sales of comparable (leased but undeveloped) oil and gas rights. This is the Comparable Sales method and proper use requires two sets of data. First, a

reliable list of the market sales of oil and gas rights including the name and location of the property and the cash equivalent price paid for the rights. This is a complex requirement that precludes the use of unsubstantiated information and lunch-counter gossip. It is incumbent on the appraiser to define the property rights sold, to determine the cash equivalent amount of the purchase/sale price, and ascertain that the transaction meets the conditions of fair market value.

Second, there must be sufficient information about the properties in the data set (location, lease terms, royalty interest, basis for buyers value, status of development, etc) to allow appropriate **adjustments** to be made among the comparable properties before application to the subject property. The information must be substantiated (documented) and verified with both the buyer and the seller. Such data sets exist for residential and commercial real estate, farm land, and other types of real estate. There is no such source of information for oil and gas properties in Pennsylvania or anywhere else. Absent reliable data, appraisal of properties based on the potential sales price is an exercise in speculation. Exhibit I presents a partial list of the characteristics of the Comparable properties that must be defined and adjusted in order to derive an indicator of value that can be applied to the subject property.

A more recent argument suggests that the production information collected and reported by the Pennsylvania Department of Environmental Protection (DEP) and/or other sources should be used to estimate the future production and income that would be obtained from a leased but non-producing and/or un-developed property. In oil and gas evaluation and appraisal this is known as using "analogy" data to approximate the performance that might be expected from a well or wells where there is no production or limited production.

The use of data from analogy wells (or leases or fields) is a commonly accepted procedure BUT it requires that certain criteria be met. The best analogy wells are those in the same lease or Unit or in the same field. Analogy wells are those whose geologic, engineering and production characteristics are identical (or closely similar) to the apparent characteristics of the subject well.

- **Location** - The analogy well should be in reasonably close proximity to the subject well. For Pennsylvania Marcellus evaluation, wells should be within a ± five mile radius. While somewhat arbitrary this distance recognizes that the Marcellus is not fully developed and evaluated and that differences in the formation can occur that would effect production potential.

- **Geology** - While it is often assumed that the Marcellus is a consistent regional geologic unit no formation created by sedimentary deposition is uniform; differences occur in the mineral composition of the shale, in the geo-mechanical structure of the shale intervals, and in the susceptibility of the formation to completion methods.

- **Completion Method** - While most Marcellus wells have been completed with horizontal wellbores and have been subjected to one or more hydraulic fracturing treatments those procedures are not identical from well to well, have varied over time, and, depending upon their success, have produced differing production results.

- **Production Performance** - The primary purpose of using analogy wells is to use the experience of those wells to estimate the future production performance of the subject well. This requires a knowledge of the certain data from the analogy well.

    - Initial Production Rate
    - Following Monthly Production Rates
    - Initial Wellhead Pressure
    - Following Months Wellhead Pressure
    - Initial Gathering System Pressure

Absent access to this data from a large number of wells from private or company sources, the only data available is the information collected by DEP. The semi-annual reports of total gas volumes and producing days are not adequate for use as analogy data. There is no monthly breakdown of production or producing days; no pressure data; and no mapping of production performance.

Until recently, operators in Pennsylvania did not have to report oil and/or gas production. In 2010, Pennsylvania began to require that operators report gas production for each well along with the number of producing days. However, the production is reported as a total volume for the prior six months. Monthly production rates are not reported and there is no pressure data or other information that would allow a performance history for the well to be defined. It is not entirely clear that the data is actual production or is sales volumes. The DEP data is not sufficient to allow an assessment of the initial production rates, decline rates, or pressure response. The DEP data allows rough comparisons between wells and producing areas but does not provide sufficient detail to be applied to a market value appraisal. Absent a comprehensive and detailed reporting system, analysis of production depends upon data obtained from interest owners.

Further, the estimation of the value of a specific property requires data which may or may not be available even if a production projection can be created. When will production start; at what rate; will there be gathering system constraints; what will be the ownership interest in the property? Assuming production starts, what will be the initial price of gas; what will be future prices; what deductions will be made from the royalty? Until (1) an adequate reporting system is developed and implemented and (2) information regarding the performance characteristics of the Marcellus Shale is published the imposition of a value based on analogy data is not a valid method of appraisal.

Appraisal of Leased, Partially Developed Properties

Partially developed properties are a subset of the leased undeveloped properties. The extent of "partial development" of the subject property must be defined. Are there any wells drilled on the property? Are there any wells drilled on adjacent/adjoining properties? Are there producing wells nearby? Have drilling permits been issued for the subject property and/or for adjacent properties? Has the operator issued a Notice of Development for the property? Are there well pads built on the property? How far is the nearest producing well? Is it operated by the same company as the subject property? How far away is the nearest gas gathering pipeline? If there are no wells drilled or in

progress on the property, how much time remains in the primary term of the lease? Is the property part of a "pooled unit" and, if so, what share of the production and sales from the unit would come to the owner of the oil and gas rights?

It may be tempting to say that since the Lessee has made some efforts toward development, such as building a well pad or running a seismic survey, there is "value added" to the property. But that value, if any, does not accrue to the rights interest except as it may eventually lead to drilling and production. Further, depending on the language of the lease, such actions could be construed as "operations" and could take the lease out of the primary term. This could result in (a) the cessation of delay rental payments and/or (b) remove the possibility of any anticipated bonuses from extension of the lease or re-leasing of the property.

As a practical appraisal matter, the degree and form of partial development has little or no impact on the value of the oil and gas rights. Absent a change in the lease terms or the start of production, there has been no change in the income to the rights owner (Lessor). Aside from the start of royalty income, certain other events could occur that could effect the value of the rights.

The Lessee does not drill but negotiates to renew and/or extend the lease for another period of time. Where there is no provision in the lease for automatic extension, the lessee would have to negotiate (1) a renewal or extension of the existing lease or (2) a new lease. The terms of a new/renewed/extended lease could include a bonus payment, increased royalty, and/or increased rental payments, however, the amounts of these payments cannot be estimated with any certainty. The estimation of the terms and duration of the new lease are subject to speculation, would include too many opportunities for material error, and would not likely provide a reliable estimate of value.

The Lessee does not drill and allows the lease to terminate. A valuation under this circumstance anticipates that, on the expiry of the primary term, the Lessee does not extend or renew the lease but allows the lease to lapse. At that time, a new lease could be written with another Lessee that might bring a bonus payment and/or additional delay rental payments at a market rate, thereby creating a new income stream that could be valued.

Given the volatility of observed leasing offers and the apparent consolidation of leased land positions by operators, the estimation of the terms that would be offered at some point in the future cannot be done with any degree of accuracy and, as with the valuation of future royalty revenue, would include too many opportunities for material error, and would not likely provide a reliable estimate of value.

The Lessee finds uneconomic production and/or determines that a well is a dry hole and terminates further drilling. In this case there is no royalty income to be valued and a very low likelihood of re-leasing the property to a third party.

The Lessor's interest, therefore, has some value or no value but neither circumstance can be known as of the appraisal date nor can the value of any future income, if any, be determined.

Appraisal of Producing Properties

The appraisal of oil and gas interests in the Marcellus that are receiving royalty income have become more common as wells are put into production, and gathering systems and pipelines are completed. Ordinarily a property that has a reliable record of natural gas production and sales should not be difficult to value using the Income Approach. The common procedure is to (i) assemble the production and sales data from several years of operation of the wells or property, (ii) define the performance of the property as to production rates and decline trend(s), (iii) project the future production based on the decline trend, (iv) estimate the future price of gas and the income from sales of gas, and (v) calculate the present value of the estimated income to the ownership interest being appraised.

Actual Production - The appraisal of a royalty interest in a specific property must rely on either production data from the subject property. The data from the property is obtained from the monthly royalty statements. Depending on the format of the statement, some data regarding production and/or sales volumes and prices can be obtained. The length of the production history for a given well or group of wells is critical to a rational appraisal. The relatively short development history of the Marcellus means that there has not been sufficient time to determine how the formation in any particular area will respond and/or how the completion methodology used in the well or wells will effect the production performance. Given the complex geology of the Marcellus Shale, it should not be expected that all wells drilled into the formation, even if completed by the same operator using the same technology, would demonstrate similar performance. Because of the difficulties in establishing production in some areas and the variability of early production in Marcellus wells, a minimum of six months stable production is necessary. Production from more than one well is preferred. Wells with 12-18 months of sustained and stable production can be valued using standard decline curve models.

Analogy Production - When a well or group of wells does not have sufficient production history to use as a basis for evaluation, the next best source is to augment that data using production information from similar wells as a model or an "analogy" for the subject property. An analogy well is usually one in the same field, producing from the same geologic formation and preferably not far away from the subject well.

Useful analogy production data for the Marcellus is limited. Creation of a reliable model for wells in a specific area requires at least 24-36 months of production performance data from a large number of wells, supplemented by information about the location of the wells and completion methods. This information is not available for Marcellus wells. There is no monthly data reported, there are no mapping services providing location information; and drilling and completion records are often delayed and/or are available only from commercial services. Absent an expanded reporting system, years of accumulating data will be required to build models for Marcellus production.

The most commonly used analogy for the Marcellus Shale is the performance of natural gas wells drilled in the Barnett Shale and, to a lesser extent, the Haynesville Shale. The Barnett Shale has been in development for almost 15 years; the Haynesville is more recent. There has been

considerable professional publication discussing the geology, completion technology, and production performance of the Barnett. Anadarko, Chesapeake, and Range Resources have all published production performance data, in the form of generic "decline curves", for the Barnett and Haynesville shales. These curves show that production from both the Barnett and Haynesville Shales demonstrate rapid decline rates in the first 6-12 months of production followed by lessening rates of decline over the next 12-48 months until a relatively stable production rate is achieved and where the stabilized rate is only a fraction of the initial rate. This performance is a function of the geology of the shale reservoir and the method used to complete the well.

The Barnett Shale does not perform uniformly across the region where it is found, no oil or gas producing formation does, and completion methods have changed as experience and knowledge have been gained. A comparison of the production based on local geology and/or completion method is not possible using generic data. In addition, the companies involved in Barnett development have their own interpretations of the performance data from their wells.

In 2008, Chesapeake and Range Resources published comparisons of the actual and/or anticipated results from the Barnett, Haynesville and Marcellus shale "plays", depicted as production rate in MCF per day versus months or days of production. These comparisons demonstrate that the Marcellus was expected to perform similar to the Barnett/Haynesville. In 2009 Chesapeake published a comparison using updated information.

In 2010, Range Resources published data from only Marcellus wells and compared the production performance of groups of wells based on (a) the date of completion (2006 through 2008) and (b) completion type for wells completed in 2009. This was followed by an updated comparison of Marcellus wells that was published in January, 2011. This data is very helpful and can be used to estimate the production from an individual well or group of wells when six months or more production from those wells is available, but caution is advised. There is no information given by Range or Chesapeake about the number or location of the wells used for the comparisons. Both Range and Chesapeake have Marcellus production in other parts of Pennsylvania and in West Virginia where the geology and performance characteristics may be different from north-central PA.

Where sufficient data is available, Marcellus wells appear to show the same form of early decline performance as demonstrated in the Barnett/Haynesville. Appraisals of early-development-stage producing wells can be done using the Barnett/Haynesville models and/or published generic Marcellus data but, until sufficient local data becomes available to build reliable Marcellus models, the appraised value must be viewed with caution.

Academic Studies - Several studies of Barnett and, more recently, Marcellus performance tend to support the generic models. These studies benefit from the use of data provided by the operating companies including daily production rates, pressure measurements, formation properties, and completion data. These studies cannot be replicated using royalty owner data but they can be used to support or reinforce estimates made from monthly data.

EXHIBIT I

The following is a partial list of the characteristics that must be identified for each Comparable Sale.

- ☐ Location - Township, County
- ☐ Acreage of Comparable Property
- ☐ Original Lessee
- ☐ Current Operator if Different
- ☐ Date of Original Lease and Remaining Term
- ☐ Date of Extension and Remaining Term
- ☐ Bonus Amount Paid
- ☐ Delay Rental Amount Paid and Remaining Due
- ☐ Extension Payment Amount
- ☐ Royalty Rate
- ☐ Standard Lease Form or Modified by Additions
- ☐ Purchase Price for Property
- ☐ Did the Purchase Price Include the Surface Estate?
- ☐ Value of Surface Encumbered by the Oil and Gas Lease
- ☐ Payments for Surface Use and/or Damage
- ☐ Subject to Deductions From Royalty for Gathering, etc?
- ☐ Is the Property Pooled or Unitized?
- ☐ Division Orders Issued?
- ☐ Well Drilling Permits Requested? Approved?
- ☐ Is the Buyer Knowledgeable?
- ☐ Was the Seller Knowledgeable?
- ☐ Any Restrictions on Accessibility to the Property?
- ☐ Any Nearby Production?

Each of these characteristics must be compared to the same characteristics of the property being valued. Where there are differences, the value of the Comparable property must be adjusted to account for each difference. If there are five Comparable properties the value of each must be adjusted. The five Sales can then be used to derive an indicator of value (such as $/acre) which can then be applied to the property being appraised to estimate a value.

Example: The Subject Property has a Royalty of 12.5% while a Comparable Property has a 16% Royalty? How much of the Purchase Price of the Comparable is due to the Difference in Royalty Rate? What if the other Comparable Properties all have Different Royalty Rates?

Experience in Pennsylvania and every other oil and gas producing region shows that, except in very rare circumstances, these criteria cannot be met; the method is not valid for valuation of Pennsylvania Marcellus oil and gas rights.