Figure 1. *Surveyors interface with the drilling company and other stakeholders to assure that the horizontal drills are within unit boundaries and support the environment.*

The vital role of survey teams

Joe Adams, RPLS, Arch Stout, RPLS, and Ken Gutierrez, Mustang Engineering, USA, consider the importance of professional survey teams in the development of shale plays.

Recent successes in the North American shale plays have dominated the news and bolstered the prospects of increased energy independence. The extent of shale formation natural gas reserves, in particular, is enormous in the US, estimated at more than 800 trillion ft^3. While the existence of these reserves has been known for decades since the first drilling took place in Texas' Barnett Shale in the early 1980s, these gigantic pockets are now more productive with advancements in horizontal directional drilling and hydraulic fracturing technologies. Basins such as Barnett, Haynesville, Bakken, Marcellus and Eagle Ford have become household names and have led to a 'gold rush' frenzy from independents and major operators. Increasingly, the plays are attracting participants from global energy producers in India, Norway and China, all eager to secure the needed acreage to explore and develop these

Figure 2. *The professional land surveyor plays a vital role in shale play development.*

Figure 3. *Survey teams stake land tract unit boundaries as well as access roads and the drilling well pad.*

reserves. One of the vital roles in the timely and cost effective development of these shale plays is that of the professional land surveyor.

The survey team

Surveyors are one of the first and last groups to be involved on a shale exploration and production project. Once the geologists have used seismic and other studies to understand the geologic formations and determine the viability of an area for drilling, landmen research property records for sub-surface mineral rights and secure leases for drilling. Then, the surveying team goes to work. Its task principally involves researching and verifying property boundaries. The work must be precise and can be complex, especially on tracts where land ownership dates back centuries and boundaries have not been recently surveyed or can be missing information from official records. Without the timely and expert work of the surveyors, there would be a bottleneck that could delay the start of drilling and subsequent services needed to produce the well.

Survey teams are responsible for establishing and staking the access roads to the well site, writing easement descriptions and marking the layout of the well pad itself within the confines of the property boundaries. Unlike the drilling of conventional vertical wells with minimal spacing , shale drilling begins vertically and then is deviated horizontally through the formation. These lateral drills, with current technology, can extend more than a mile and are usually completed in multiple directions from a single pad. The surveyor's responsibility is to ensure these laterals do not encroach upon unleased properties.

Surveyors are involved throughout the lifecycle of the project. Because of the rapid growth of activity in the shale plays, the infrastructure and means of delivering gas to market has been underserved. Gathering pipelines are needed to carry gas from the wellhead and treatment facilities to existing trunklines. Reconnaissance, surveying and mapping of the right-of-way are required to ascertain and construct the most direct pipeline route, while addressing environmental concerns and surface property rights. While often not as complex as surveying for production where sub-surface mineral rights are concerned, pipeline surveys have to be undertaken by knowledgeable surveyors licensed to perform in the state.

Importance of the unit survey

The size of the shale plays can be enormous, larger in land area than some states within the US or many countries around the world. For example, the Eagle Ford shale trend extends more than 300 miles in length and is 50 miles wide, cutting a 10 million acre swath through South Texas. The Marcellus, currently with the largest natural gas deposits found in North America, covers approximately 100 000 square miles in portions of eight states in the northeast US. Land parcels in the areas being explored by shale gas players come in all sizes. Leases range from small tracts of under 10 acres to sizeable ranches of hundreds of thousands of acres. In order to accommodate the horizontal drilling, the parcels must be bundled into units; depending on the state, the size of the unit varies. In Texas, for example, the unit cannot exceed 704 acres, whereas in the Marcellus play through Pennsylvania, the unit's size is a maximum of 640 acres. Drilling rig spacing is also dictated by state regulations and can vary from state to state.

Accuracy of the unit and the leases within has to be precise. Once the unit is established and the plat is certified by the surveyor, the operator provides a division order establishing the exact percentage of royalty entitlement in the unit for each individual landowner. Further calculations must be made by the surveyor in instances where part of a tract is within the unit and part is outside, or in an adjoining unit. With royalty payments escalating astronomically in the high activity shale plays, precision of ownership calculations is paramount. The surveyor works closely with the drilling company by providing

survey grade positions of the property and unit lines to help prevent drills from extending beyond the limits of the unit lines or encroaching into unleased parcels.

Challenges facing the surveyor

Time is of the essence when working in the shale plays. The leasing of units is a dynamic function because of the terms of the lease, expiration dates and the human factors involved with signing agreements. Seemingly minor delays can have a significant impact on the unit, as tracts under lease continue to expire, causing redefinition of the unit boundaries. Since many of the shale plays are in remote locations surrounded by grasslands or forested areas, activities such as hunting seasons and holidays can cause local roads to be shut down, delaying movement of drilling rigs and other equipment. Weather problems, particularly in northern regions, can also hamper rig movement and drilling activity.

Because of the volume of activity, there is a shortage of experienced and qualified personnel in virtually any of the shale basins. Experienced landmen are in high demand, and county court buildings are overwhelmed with the increased workload placed on their staffs to support the searching of property records for legitimate mineral rights owners. Capable local surveyors are overworked, understaffed and face challenges of handling the size and number of leases simultaneously. Field survey teams generally consist of a survey supervisor and multiple survey crews. The volume of work, aggressive schedules and the dynamic nature of unit surveys can present challenges to the local surveying teams in terms of staffing and resources.

There are considerable changes in ownership in large portions of the shale plays, as new companies are formed and existing players sell parts of their leases to companies desiring to be part of this dynamic natural gas segment. Additionally, the unit boundaries are continually changing as leases expire and additional property is added to the unit.

Costs are not limited to lease expirations and renewals with landowners that might exceed many times the cost of what they were when originally leased just three years prior. The operators, in anticipation of securing a permit to drill, engage a drilling contractor for that purpose. The projected drilling start date is critical. With rates for active rigs and their crews often at close to US$ 100 000/d, delays can be costly to the operator, even at standby rates while drillers await final permitting.

Choosing a survey team

To work in the shale plays, there are some obvious attributes for the hiring of survey companies that will ultimately benefit the operator, drilling contractor, landmen and landowners, all stakeholders with whom the surveyor must interact.

Experience

Because of the volume and complexity of unit leases and their makeup, experience is a significant factor in selecting a qualified surveying company. The nature of shale play drilling operations impacts the creation of units that must comply with state regulations. Surveying companies must include a licensed surveyor for that particular state. The firms should also have expertise in the use of the latest tools, including survey grade global positioning systems (GPS) and real-time geographic information systems (GIS) reporting software that keeps track of the myriad data generated during the survey in order to relay maps and other pertinent information to the field instantaneously.

Flexibility

Surveyors in the shale plays are operating with a ‘moving target’. With lease ownership changing and leases expiring continually, the size and configuration of the unit are dynamic and require numerous revisions which must be managed to ensure a quality work product is delivered on schedule to avoid costly delays.

Size

The number of available survey crews is a continual challenge in the shale plays because of the increasing volume of work. Well-staffed companies can provide the necessary office support and field crews and can mobilise them to where they are needed. An integrated survey company will have performance metrics, standards and procedures in place that will ensure consistency in all deliverables.

Integrated services

Providers of multiple services in shale plays make it simpler for operators to reduce the number of vendors or perhaps even utilise a single source. This integration is often available in the pipeline segment with firms that integrate right-of-way and environmental permitting in conjunction with the surveying capability.

Drilling in shale plays is developing at a rate that has made resources scarce and costs increase exponentially. It is an exciting time, and the surveyor, with capabilities to perform quickly and accurately and be flexible in adjusting the unit surveys to fit the drilling activity, has become a valued participant in the quest for natural gas. OT