A Finding and Development (F&D) Model For Making Money by Finding Gas Where it is

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ABSTRACT

Amoco Canada (now BP Canada Energy Company) has developed a strategy based on finding and development cost to focus on plays that provide large resource potential at low F&D cost. A model was developed to estimate finding and development cost for a variety of natural gas plays in the Western Canadian Sedimentary Basin using the Geological Survey of Canada's assessment of undiscovered resource and the Energy & Utilities Board's pool and well data. The model yielded a ranking of each play plus a series of undiscovered resource and play maps which Amoco used to develop a new exploration strategy. The goal of the new strategy was to find and develop reserves that could provide low risk, top quartile finding and development performance. The strategy study helped Amoco to focus its efforts, drop the pursuit of marginal plays and become more proactive in areas of greater opportunity.

INTRODUCTION

In every exploration program a company must decide which opportunities to focus on and which to ignore. Often, these decisions are based on ingrained misconceptions of resource potential or reactions to competitor activities. An alternative approach is to develop a strategic framework for exploration that attempts to maximize value. This paper describes the method used to develop an exploration strategy aimed at identifying areas capable of delivering large reserves at low risk and at top quartile finding and development (F&D) cost.

AMOCO CANADA'S (BP) EXPLORATION STRATEGY IN THE 1990s

Prior to 1997, Amoco had a separate exploration department that had to compete for funding with opportunities from around the world in the Company's global exploration program. This resulted in a focus on the pursuit of large, high-risk gas pools in the Western Canada Sedimentary Basin (WCSB) rather than on year-on-year economic performance. During the 1990's the Canadian exploration department had limited success with this focus and, in hindsight, destroyed shareholders' value.

In 1997, Amoco Canada was reorganized into the Canadian Gas Business Unit and the exploration department was eliminated. In the new organization, the focus was on maximizing the value in Amoco's core producing areas, with the target of reducing F&D cost to WCSB top quartile performance. In addition, three teams where formed to find new natural gas opportunities either outside of the core areas or within the core areas but in zones that were not actively being pursued. These new, small "e" exploration teams were charged with providing drilling opportunities which would find additional reserves with an average drilling success above 50% at top quartile F&D cost. Although total resource size was still important in this approach, the focus was on economic success rather than on the size of any individual prospect.

Hence, in 1997, these teams began an assessment to identify geographic areas and geological zones that could provide new gas reserves at low F&D cost. Amoco had recently acquired the latest detailed Geological Survey of Canada's (GSC) WCSB resource assessment. This data

plus the Energy and Utilities Board (EUB) historic pool and well data became the cornerstone of the F&D exploration study.

PETRIMES BASED F&D STRATEGY

The GSC resource assessment provides a detailed analysis of geological producing zones, and includes play boundaries, discovered resources and a prediction of the undiscovered resources and pool size distribution for plays in the WCSB (Figure 1). This data set was augmented by Energy and Utilities Board (EUB) pool and well data to establish probability distributions of production rate, gas composition and recovery factor for each play (Figure 2). With this data, an F&D model was used to calculate the cost to find and develop pools of different sizes in each play. This information was then used to rank the plays in terms of F&D cost and remaining undiscovered resource potential.

The F&D model approximated the cost to both find then develop a gas pool. The model was based on the equations below.

$$\text{Finding cost} = \frac{well + seismic + land}{P_s * \text{Re}serves} \text{ and,}$$

$$\text{Development cost} = \frac{\#wells * (well + wellsite) + dehy + compression + pipeline}{P_{sd}\ \text{Re}serves},$$

Where the terms in the numerators were costs:

#well: number of development wells (depends on the pool size and reserves per well)
well: cost per well (a function of depth see Figure 3)
wellsite: facility cost for each wellsite
seismic: seismic cost per well (depends on whether 2D or 3D seismic was needed)
land: cost for land assumed at fixed cost per hectare and one section per well.
dehy: cost for the pool assuming central dehydration facilities were needed
compression: compression cost for the pool
pipeline: Cost of the pipeline (sized based on gas rates from the pool; also dependant on whether pool is in Alberta or BC),

and the terms in the denominator are reserves:

P_s*:* probability of exploration success (based on historical success rates and perception of play risk)
P_{sd}: probability of development well success (based on historical success rates and perception of play risk)
reserves: calculated from resource using historical numbers for shrinkage and recovery factor

Using the GSC resource assessment, the predicted undiscovered pools were divided into seven subsets for each play based on pool size range: less than 5bcf; 5-10bcf, 10-25bcf, 25-50bcf, 50-100bcf, 100-200bcf and >200bcf .Each pool size subset was considered as a separate play and F&D costs to pursue each play subset were calculated and ranked (Figure 4). In addition, each play subset was ranked on the basis of remaining undiscovered reserve potential (Figure 5).

The plays were either accepted or rejected on the basis of F&D cost and/or the remaining undiscovered reserve potential. The plays that were accepted were represented on two regional maps. The first map (Figure 6) showed the accumulated reserve potential of all the accepted plays. This map was made based on the assumption that the reserves associated with each play are uniformly distributed within each play's respective boundary. The second map (Figure 7) simply showed the distribution of each play in order to highlight areas where multiple plays overlap. Such areas would be expected to have greater multi-zone potential.

The maps, together with the play rankings based on F&D costs and potential undiscovered reserves, provided a regional assessment of all plays that enabled Amoco to focus on geographic areas and plays that could provide larger resource potential at low F&D cost and relatively low risk.

CONCLUSSION

There were several benefits to the F&D study. First, it showed that some of the plays that Amoco was pursuing provided limited resource potential at a high F&D cost. We were able to confidently drop these plays to focus on more rewarding opportunities. The F&D study also helped to eliminate reacting to "noise" due to competitors' actions. For example, if a competitor posted a large parcel for an upcoming landsale, a bid at the sale would either be considered or ignored based on the knowledge gained from the F&D study. Finally, the study helped to focus Amoco's efforts to become proactive in pursuing high value play opportunities outside of our established core areas.

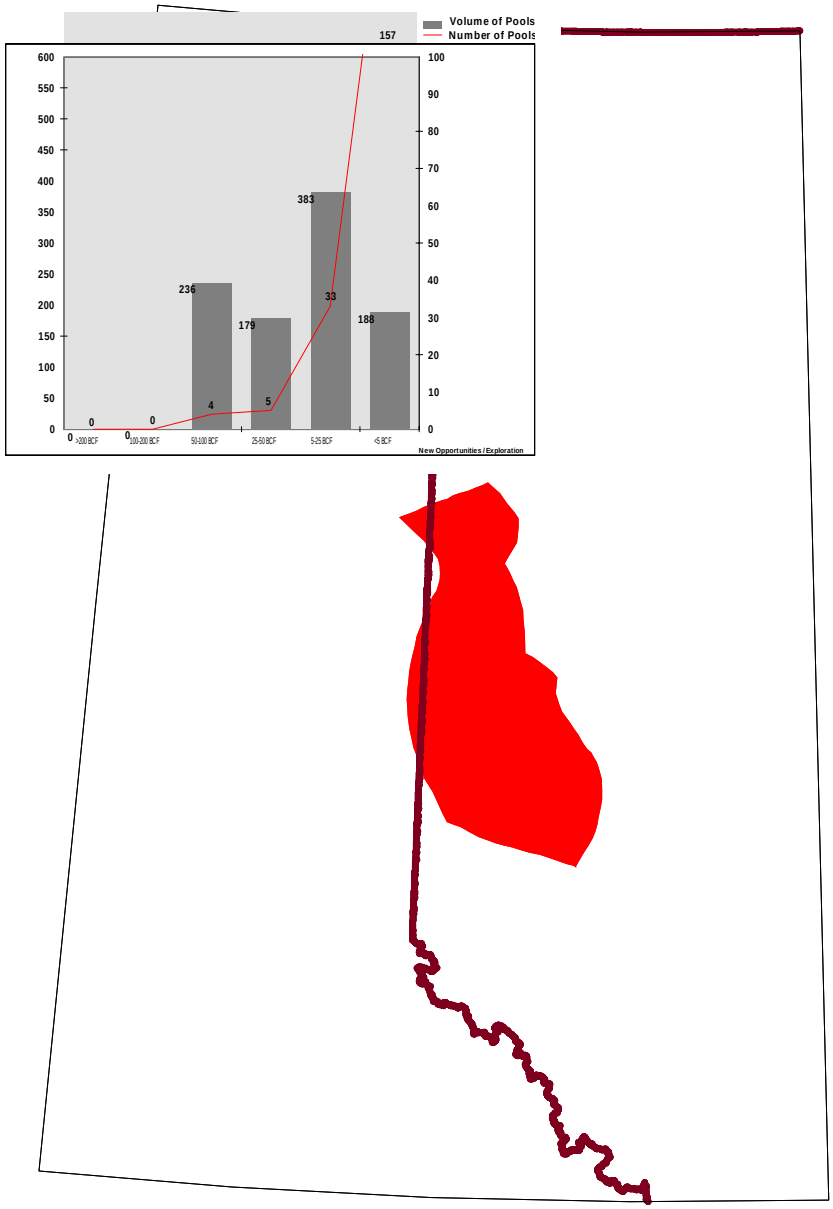


Figure 1 shows the atlas page for the Halfway formation. The histogram shows the distribution of undiscovered pools as predicted by the GSC study.

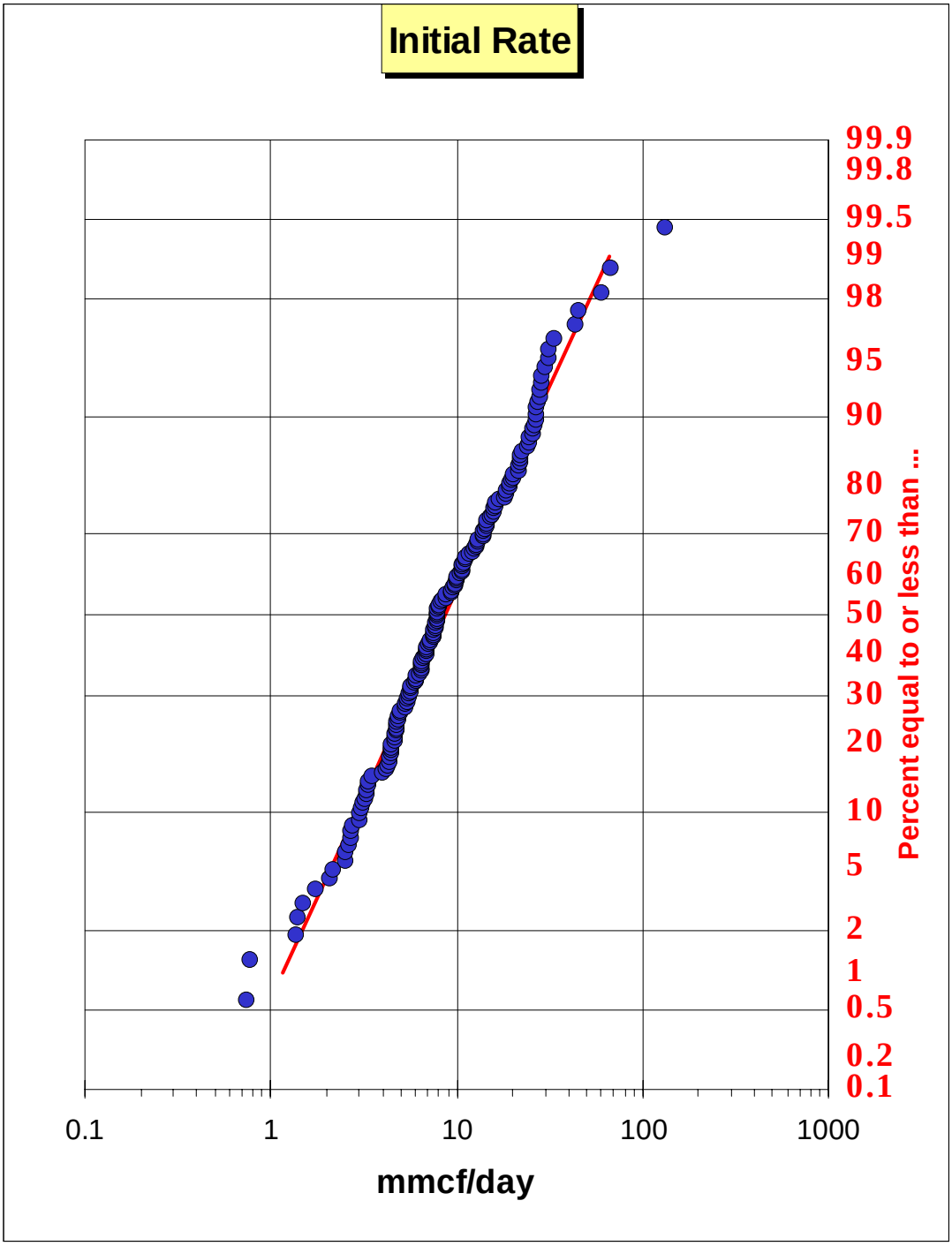


Figure 2 shows an example of the statistical data acquired form the EUB pool data. The graph shows initial gas rate versus the probability of flows of that rate or lower. Typically a P_{50} value was used in the model.

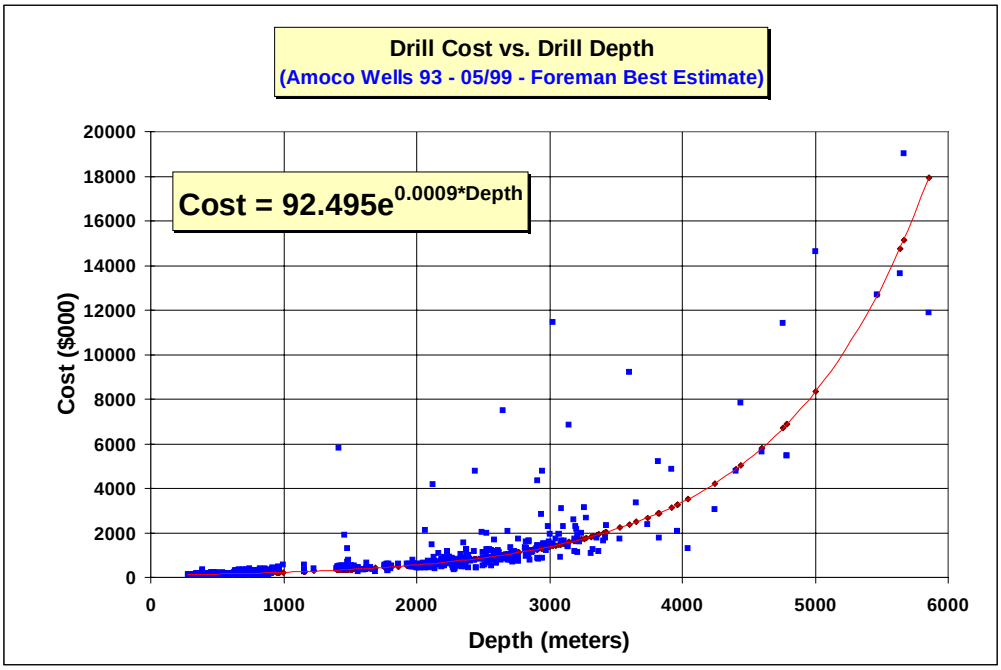


Figure 3a shows the drilling cost versus drilling depth for Amoco wells from 1993 to 1999.

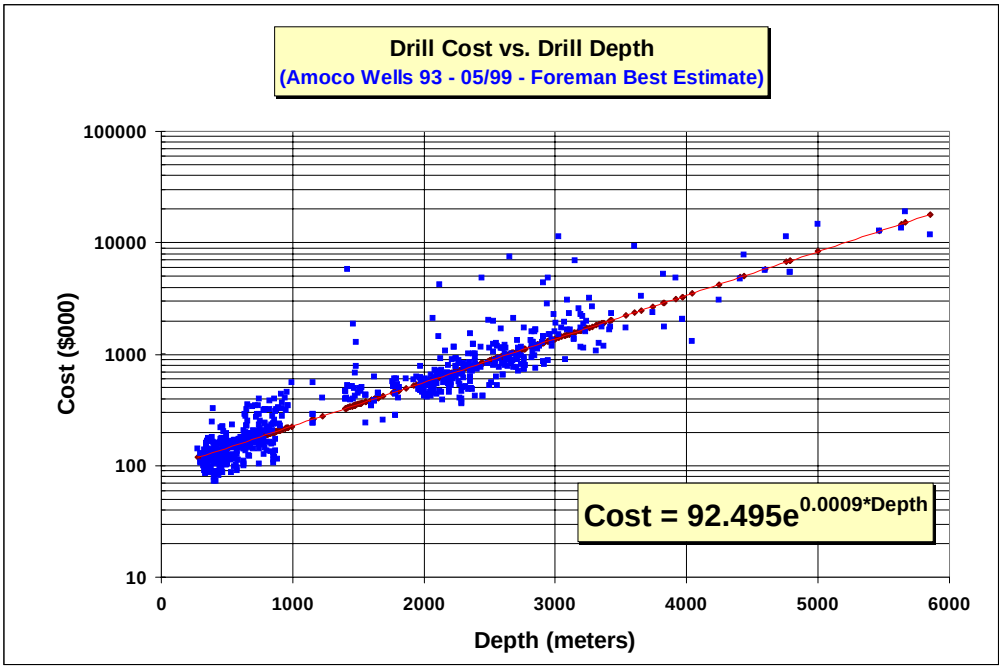
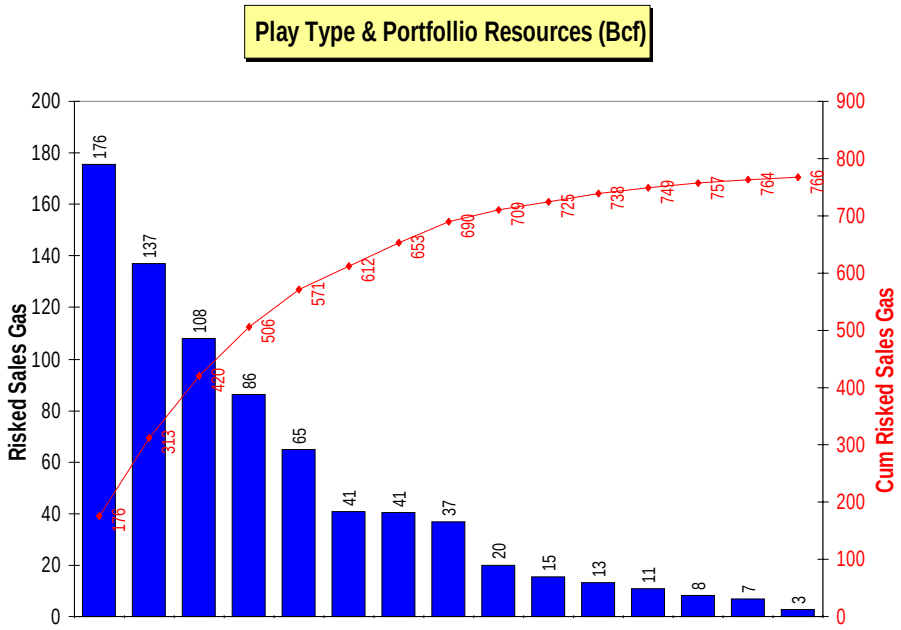
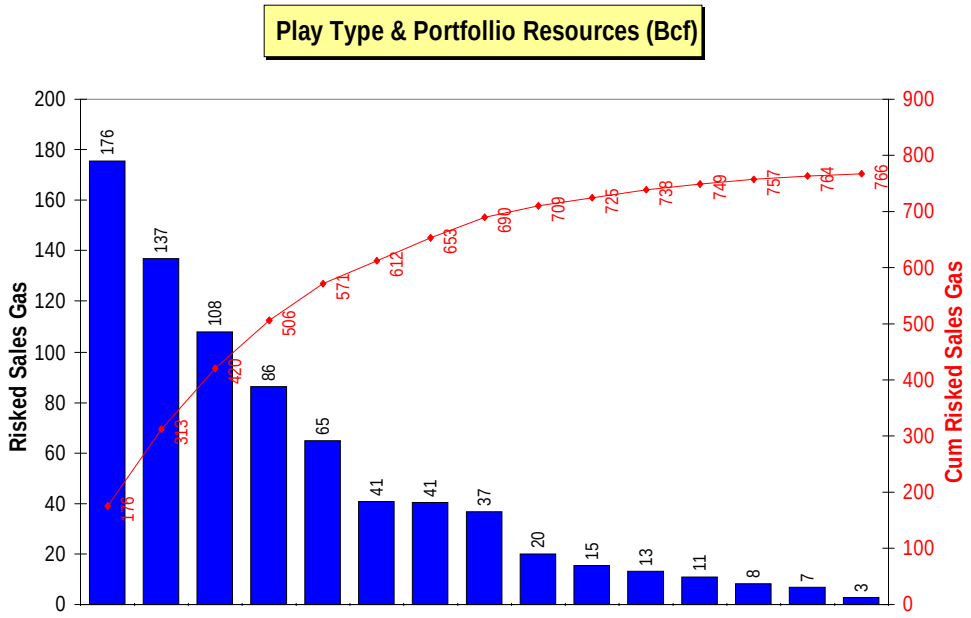


Figure 3b shows the log cost versus drilling depth for Amoco wells from 1993 to 1999.



In **Figure 4** the bars show F&D cost for individual ranked play types. The red line shows the cumulative F&D cost of pursuing plays up to a play type. For example, all the plays up to $1.34 could be pursued for a combined F&D cost of $0.62.



In **Figure 5** the bars show the estimated risked sales gas resource potential for each play. The line shows the cumulative sales gas resource potential.

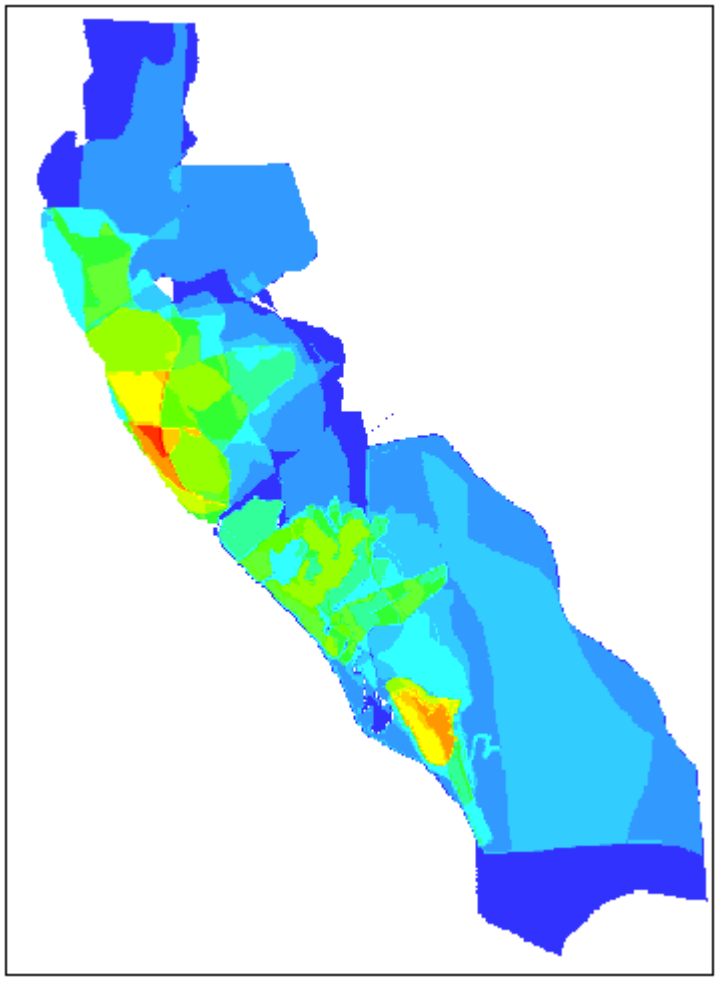


Figure 6 shows a color-contoured map of the overlapping resource potential in the study area. “Hot” colors represent a greater resource potential in that area. Only plays that passed an F&D cost cutoff were included on the map.

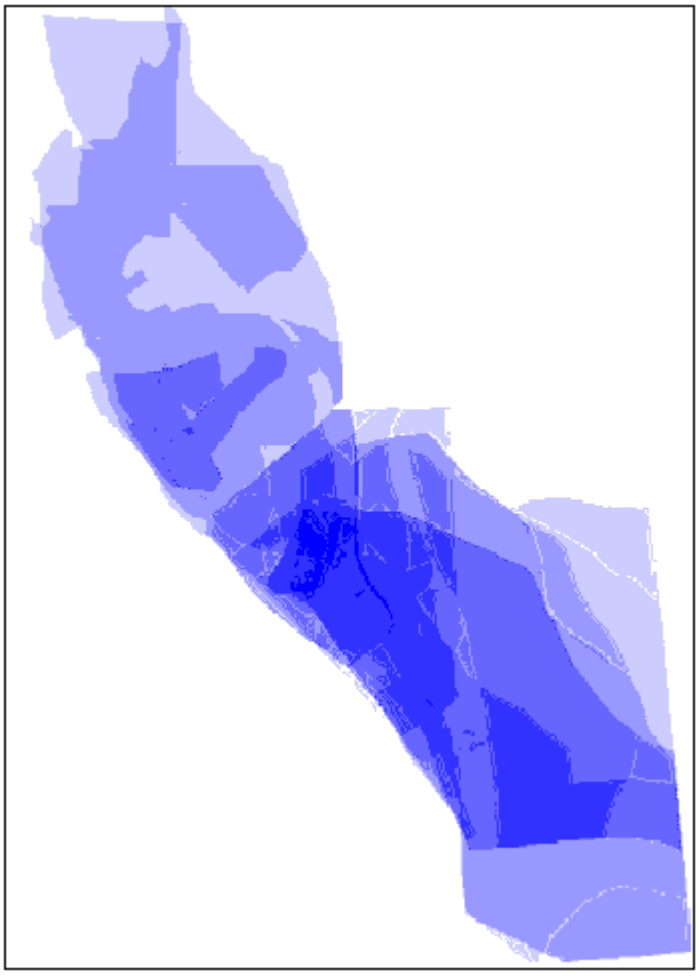


Figure 7 is a contour map of the play density over the study area. Darker colors represent a greater number of overlapping plays.