OPTIMUM DIRECTIONAL SURVEY SPACING

by

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ABSTRACT

The cost of a directional survey for any section of a well depends on the number of stations comprising the survey. However, each additional station adds to the precision of the bottom hole location and hopefully to the revenue of the well.

The objective of this study is to present an analytical method for the selection of directional survey spacing. Two examples of the spacing selection are presented using real field wells. Long's method is the survey calculation method used for the reduction of spherical station measurements to Cartesian coordinates. Stability theory is employed to define the locations of the well bores of the two field wells.

This thesis demonstrates procedures and analytical methods for the selection of directional survey spacing for a directional well.

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Chapter 1

INTRODUCTION

The purpose of this study is to present an analytical method for the selection of directional survey spacing for a directional or horizontal well. A directional survey is a collection of data measured systematically throughout a directional well. A location at any depth within a well, where the data are measured, is called a directional station or simply a station. The minimum data measured at a station are measured depth, bore hole inclination, and azimuth. Directional survey spacing is the along the well distance between adjacent stations. While this distance is not precisely constant in the making of a field survey, most surveys will be planned to have a single definite spacing. Common field practice calls for spacings of 15 feet, 30 feet, and 90 feet.

The method presented in this thesis for optimum survey spacing selection is based on the combination of two models written for this research. These are referred to as the petroleum hydrocarbon production revenue model and the survey cost model. While they are explained in detail in the chapter II, a brief discussion is presented here. The production revenue model produces revenue and the survey cost model gives expenses. The difference between revenue and expenses is a profit. The optimum directional survey spacing is defined as the survey spacing which yields the highest profit. The production revenue model is written such that as the ideal directional target location is missed the well hydrocarbon production is lost and revenues are decreased. Further, a big miss means all revenue is lost. The underlying truth in the survey cost model is that surveys which have more stations cost more.

The heart of the study and the ingenuity is the procedure for analytically describing the location of the bottom most station of a directional survey for different survey spacings. Therefore a dependence of the bottom hole apparent movement of the well in regard to survey spacing must be developed. Further, this dependence must be established in a manner which will be as free as possible of other well and tool variables. The procedure chosen in this research was to select a single survey of a well which contained all the survey stations and then systematically reduce the number of survey stations. Keep in mind that reducing the number of survey stations in a particular survey will increase the survey spacing for the well. The systematic reduction in the number of stations was done by deleting a specified station from a sequence of stations. For example, if alternating stations were deleted then one-half of the stations would be retained. If the third, sixth, ninth, etc., were deleted then the first, second, fourth, fifth, etc., stations would be retained in the survey.

Two directional surveys from two real field wells are analyzed and reported in this research. The first survey from the well contained 1,958 stations and the second well contained 288 stations. For the first well, sixty-four (64) surveys were generated with this method and twenty-seven (27) surveys were generated for the second well. The systematic station deletion sequence for the first well retained 69 of 70 stations for the first generated survey, 59 of 60 stations for the second generated survey, then 49 of 50, 39 of 40, - - -, and finally the sequence terminated when 1 of 100 stations were retained. Note that this last generated survey contained 22 stations. The sequence for the second well retained 9 of 10 stations, 8 of 9, - - -, and finally 1 of 19 stations for the last term of the sequence. The last generated survey for this well contained 16 stations.

The factors, which create errors in directional surveying such as, magnetic interference, directional tool and well miss-alignment, well and tool carrier miss-alignment, directional tool's inclination and azimuth calibration, and drill string measurements will all be common and similar, if not equal, for all and any survey station with systematic procedure. This can not be if the wells were directionally surveyed in separate and distinct survey runs even if the same directional tool and carrier were used.

Mitchell[1] gave the name *stability* to the apparent movement of a station's location if the movement is derived from a collection of generated surveys which were extracted from one parent directional survey. The term carries the same meaning in this research. He invented the definition and assigned the nomenclature *stability* to explain the concept captured in the following bit of logic; one would expect that the locations of all stations in a well to become more precise as the number of stations are increased in a survey. In this research the numerical value of stability is assigned the value attained by dividing the distance by which the bottom hole station's location departs from the best bottom hole location. For example let the best bottom hole location have the value of 1,000 feet and a movement distance of 10 feet for a generated survey which contains deleted surveys, then the stability value for the location of the bottom of the hole will be 10/1,000 or 0.01.

The best bottom hole location in this research assigned a value as determined with the infinite extrapolation method[14]. The assigned value is determined by constructing a plot of bottom hole location on the ordinate and the reciprocal of the number of stations in a series of reduced generated surveys on the abscissa and extrapolating the resulting data points to the ordinate axis. The intersection of the extrapolation of the data points and the ordinate represents the value which would have been attained with a survey which contained and infinite number of stations. Again, the rational supporting this procedure for ascertaining the best bottom hole location is that a survey which contains the most stations is the most precise survey.

Long's[13] computational well bore trajectory model is employed in this research for the calculation of station locations within a survey in 3-dimensional space. It was chosen because it is the most advanced of the popular circular arc models.

The Louis expected value method of evaluating an event by which a decision may be reasonably made is the basis for formulating the survey cost model.

As written above, the surveys reported in the examples within this thesis are surveys from real field directional wells. The two wells are coded by the letters DRL and DBM. The donor of the surveys requested that neither the true names nor the locations of the wells be published.

Raw survey data which is a collection measured depths, inclinations, and azimuths were transposed to Cartesian coordinates, azimuths, and distances, with Mitchell[1] Engineering's directional drilling software.

The directional data and computed variables which are displayed as tables in this thesis are recorded in Microsoft's Excel spreadsheets.

Chapter 2

ECONOMIC MODELS

2.1 Introduction

Two economic models are developed in the following sections. The first model is the petroleum production revenue model. Its purpose is to provide an analytical relationship between petroleum production revenue and the precision of directional surveys. The analytical relationship is presented as an equation.

The second economic model is developed and presented to provide an analytical relationship between the cost of directional surveying and the number of survey stations within the survey.

2.2 Petroleum Hydrocarbon Production Revenue Model

The petroleum hydrocarbon production revenue model written for the research in this thesis is simplistic yet serves as a realistic model for illustrating and demonstrating the fundamental method of spacing selection.

The revenue model is not commensurate with petroleum engineering reservoir models which have been developed by the Petroleum Engineering staff or students at the Colorado School of Mines. Further, this model should not be construed to be the only model which can be used with the selection concept posed in this thesis. The petroleum production revenue model is depicted in Figure 1. It is a cylinder of radius R, height h, and has a rock volume as given by the following formula.

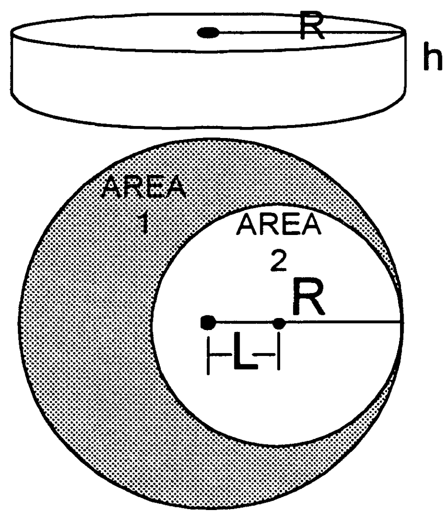

Figure 1. Reservoir Model

$$\text{ROCK VOLUME} = \pi R^2 h \quad (1)$$

The hydrocarbons are found only within the pores of the rock and the hydrocarbon volume is further reduced by the water which occupies a portion of the pores as do the hydrocarbons. Further, only a fraction of the hydrocarbons can be moved and recovered from the reservoir. Finally, this volume must be reduced by the evaporation of the gaseous hydrocarbons and a drop of the hydrocarbon's temperature after collection in a tank.

The common equation for computation of recoverable hydrocarbon volume from a reservoir is as follows. This volume is called the volumetric hydrocarbon production volume.

$$HP = \frac{7{,}758\,\pi\,R^2\,h\,\phi\,(1-Sw)\,R_f}{43{,}560\,B_o} \qquad (2)$$

The revenue generated by hydrocarbon production is the number of volume units of hydrocarbon produced multiplied by the value of the hydrocarbon per unit volume.

$$REVENUE = HP * PC \qquad (3)$$

where :

B_o = formation volume factor, fraction

HP = hydrocarbon production, STB

h = height of the hydrocarbon reservoir, ft

PC = hydrocarbon value per STB, $/STB

R = radius of a circular hydrocarbon reservoir, ft

R_f = hydrocarbon recovery factor, fraction

S_w = water saturation within the porosity of the reservoir rock, fraction

$\varnothing$ = porosity of the rock within the reservoir boundary, fraction

1 acre-ft = 7758 bbl

1 acre-ft = 43560 ft^3

The hydrocarbon production revenue model assumes that if the directional well does not intersect the center of the reservoir then only a fraction of the hydrocarbons contained therein can be produced. The hydrocarbon volume shown as a shaded area designated as area 1 will be unrecoverable and lost if the distance by which the center of the reservoir is missed by the directional well is L.

The hydrocarbons in area 2 are recoverable. The equation which may be used to compute the volume of recoverable hydrocarbon which contains the concept of the well not intersecting the center of the reservoir is given by the following equation.

$$HP = \frac{7{,}758\,\pi\,(R-L)^2\,h\,\phi\,(1-Sw)\quad R_f}{43{,}560\,B_o} \tag{4}$$

where :

L = distance from the center of the reservoir, ft

The following example computations illustrate the procedure for ascertaining the hydrocarbon production and revenue from a reservoir. Also, in the examples for ascertaining the optimum spacing for the two directional wells, DRL and DBM, these same reservoir values were assigned to the required parameters.

B_o = 1.2 RB/STB

h = 10 ft

PC = 14.00 $/STB

$R \quad = 330$ ft

$R_f \quad = 0.40$ fraction

$S_w \quad = 0.45$ fraction

$\varnothing \quad = 0.15$ fraction

The hydrocarbon production volume as computed with equation (1) above is the following.

$$HP = \frac{7{,}758\,\pi\,R^2\,h\quad\phi\,(1-Sw)\quad R_f}{43{,}560\,B_o} \qquad \textbf{(2a)}$$

$$HP = \frac{7{,}758\,\pi\quad 330^2 * 10 * 0.15 * (1-0.45) * 0.40}{43{,}560 * 1.2} \qquad \textbf{(2b)}$$

$$HP = 13{,}847\ STB$$

The revenue from this hydrocarbon production as computed with equation (2) above is the following.

$$REVENUE = HP * PC \qquad \textbf{(3a)}$$

$$REVENUE = 16{,}756 * 14.00$$

$$REVENUE = \$234{,}584$$

If the center of the reservoir is missed by the directional well by a distance of 30 feet, the hydrocarbon production and revenue as computed by equations (3) and (2) are the following.

$$HP = \frac{7{,}758\,\pi\,(R-L)^2\,h\,\phi\,(1-Sw)\,R_f}{43{,}560\,B_o} \qquad \textbf{(4a)}$$

$$HP = \frac{7{,}758\,\pi\,(330-30)^2 * 10 * 0.15 * (1-0.45) * 0.40}{43560 * 1.2}$$

$$HP = 13{,}847\ STB$$

$$REVENUE = HP * PC \qquad \textbf{(3a)}$$

$$REVENUE = \$193{,}858$$

The revenue lost in this example computation is the difference between $234,584 and $193,858 which is the amount of $40,726. The percentage loss is 17% of the $234,584.

This same procedure for the computation of revenues as illustrated in the above example was applied for the computation of revenues which appear in the Microsoft Excel spreadsheet tables shown in Appendix C.

2.3 Survey Cost Model

The cost model is the composite of costs of conducting and analyzing a directional survey at the well site and contingencies associated with failures.

In the extreme case failure to properly survey a well does cause the well to be abandoned. In this research direct survey costs include rig time, preparation time for surveying, surveying time, and MWD rental. Failure costs which are also called troubles include the costs of fishing, sidetracking, and abandonment.

Figure 2. is a flow chart of surveying cost. The chart shows that trouble will occur during two percent of the directional surveys conducted. Ninety-eight and nineteenths of these troubles may be resolved after two days of fishing. One percent of the troubles will require sidetracking and only one one-hundredths of the wells on which surveys were attempted will require abandonment.

For the wells which had trouble and fishing was required for two days, rig time costs and fishing tool costs will be charged at 100 percent. For the wells which required sidetracking, rig time, fishing tools, and cementations, will be charged at 100 percent. Further it is assumed that the first sidetrack will be successful 80 percent of the time; and if not, the sidetrack must be repeated at the same cost as the first sidetrack. Now, if the second sidetrack is not successful, a third sidetrack will be required and its success percentage is 60 percent. These costs are iterative through five sidetracks. If the fifth sidetrack fails then the well is abandoned.

The equations for computing the trouble cost components of the surveying costs are the following.

$$FC = 98.9\% * 2 * (24 * RC + Ftc) \tag{5}$$

$$\begin{aligned} ST = 1\% * 2 * [&80/100*(24* RC + TC + CC) + \\ &70/100*(24* RC + TC + CC) + \\ &50/100*(24* RC + TC + CC) + \\ &20/100*(24* RC + TC + CC) + \\ &10/100*(24* RC + TC + CC)] \end{aligned} \tag{6}$$

$$AC = 0.01\% * Apc \tag{7}$$

Then, the total trouble cost may be computed with the following equation.

$$TBC = 2\% * (FC + ST + AC) \quad (8)$$

where:

RT = Rig time, hour

RC = Rig Cost, $/hour

Ftc = Fishing tool Cost, $/day

MWDt = Measurement While Drilling Tool Cost, $/day

FC = Fishing Cost, $

ST = Sidetracking Cost, $

TC = Tools Cost, $/day

CC = Cementing Cost, $/day

Apc = Processing of Abandoning Cost, $

AC = Abandoning Cost, $

TBC = Trouble Cost, $

PS = Preparation for survey cot, $

MWDR = MWD Rental, $

NTC = No Trouble Cost, $

SC = Survey Cost, $

As written above, surveying cost consists of trouble or no trouble with the probabilities of 2% and 98% shown in the chart. The above explains the trouble portion of the survey cost model. The following explains the no trouble portion of the model.

The components of no trouble are rig time, survey time, and MWD rental. The survey time per stations requires between 3 to 5 minutes in most operations. Preparing the rig for a survey requires about 30 minutes. MWD rental is on a daily basis.

Therefore, the rig time equation is the following.

$$RT = stations * 5/60 * RC \quad (9)$$

The preparation for surveying equation is the following.

$$PS = 30/60 * RC \quad (10)$$

The MWD rental equation is the following.

$$MWDR = stations * 5/60 * MWD/24 \quad (11)$$

Then, the equation for computing the no trouble cost is the following.

$$NTC = 98\% * (RT + PS + MWDR) \quad (12)$$

Now, the total cost of conducting a directional survey may be computed with the following equation.

SC = NTC + TBC **(13)**

From equations (8), (12) and (13), the survey cost model can be written in the following form.

SC = 98%*(RT + PS + MWDR)+ 2%*(FC + PS + AC) **(14)**

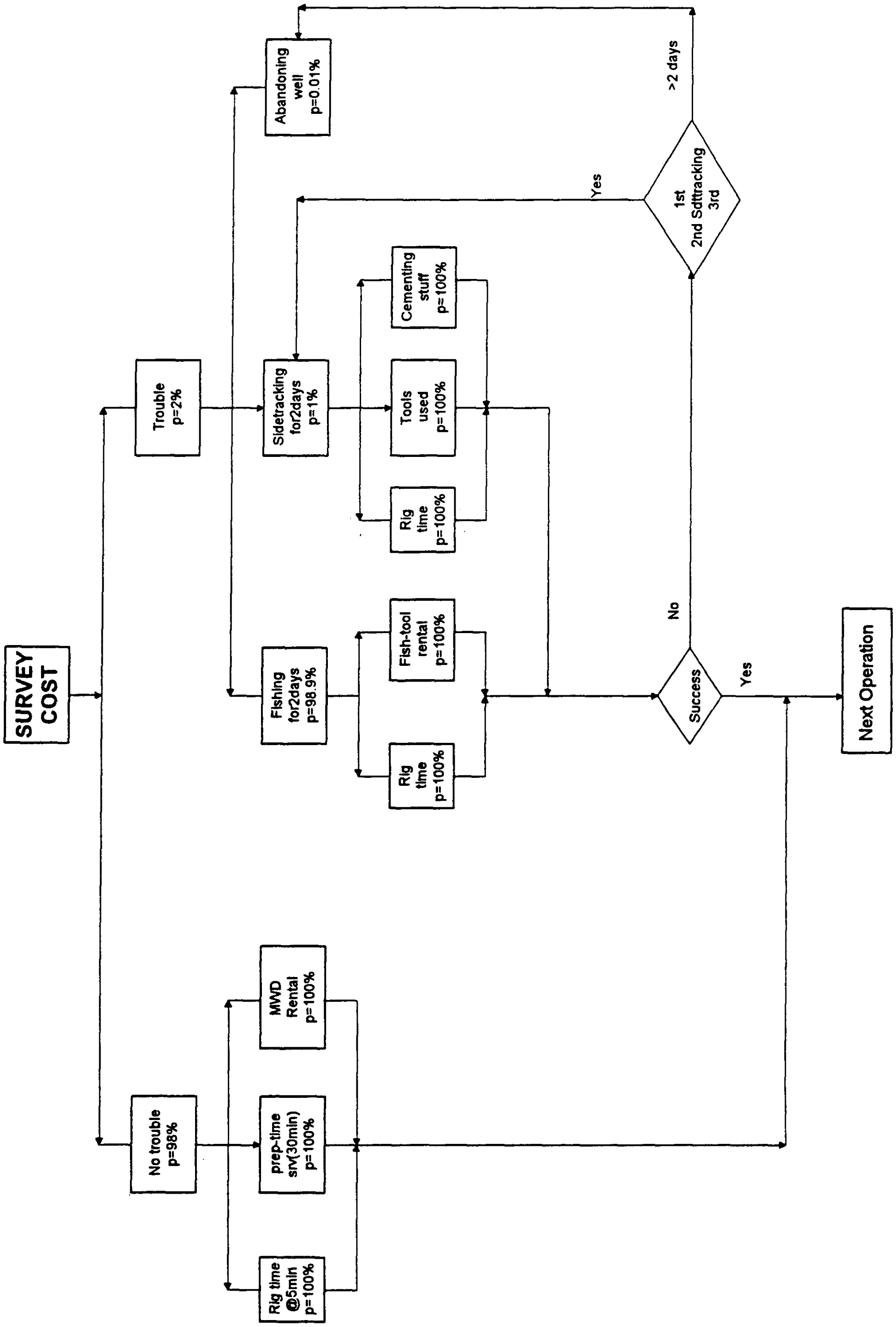

Figure 2. Survey Cost Flow Chart

Chapter 3

DIRECTIONAL SURVEY SPACING SELECTION MODEL

3.1 Introduction

The development of the directional survey spacing selection model which was presented in the foregoing chapter is applied in the following sections to the two field wells. These wells are described in detail in Appendix C. The directional survey spacing selection model is recapitulated in Appendix D. It must be kept in mind that the spacing model is an amalgamation of the supporting models.

An expected profit value model is developed for the purpose of connecting the economic revenue model with the directional survey cost model. The model is developed in the following section and applied to the two field wells in Appendix C. The model is based on the theory invented by Louis in 1850. His theory requires that the sum of all probabilities of all events be equal to unity. His theory also requires that the sum of the products of the cost of all events after multiplication by the their related probabilities be the expected value or in this research the profit.

A well bore stability model is employed for the purpose of ascertaining the best bottom hole location for the two field wells. The best bottom hole location is required for the development of analytical relationships between petroleum production revenue and the location of the bottom of the well. The explanation of the stability model is presented in the following sections and the model is demonstrated in Appendix B.

Long's well bore trajectory model is required to transform directional survey measurements which are in spherical coordinates to well bore trajectories in Cartesian coordinates. The Cartesian coordinates are required to locate the bottom of the well bores. The model is presented in the following section and is applied to the two field wells in Appendix C.

3.2 Expected Profit Value Model

The expected profit value model combines Long's model for well bore locations, the stability model for the best bottom hole location and the well bore displacement from the best location, the petroleum production revenue model for revenues, and the survey cost model for costs, for the purpose of analytically relating profit to survey spacing. The steps for developing the expected profit value model are listed in the following and recapitulated in exacting detail in Appendix D.

STEPS

1. Long's model is employed to transform the survey data to Cartesian coordinates. Refer to Long's Model section for a description of the process.
2. The stability model is employed to ascertain the best bottom hole location for a well, displacements from the best location with reduced surveys, and the relationship between the displacement of the bottom hole location and the number stations in a reduced survey.
3. The petroleum production revenue model is employed to ascertain the petroleum production and revenue for bottom hole locations which are displaced from the best location for each reduced survey.
4. The survey cost model is employed to ascertain the cost of each reduced survey.

5. The revenue model and survey cost models are combined to form the expected profit model from which the optimum survey spacing is selected.

The following section illustrates the steps 3, 4, and 5 of the foregoing listed steps. Steps 1 and 2 may be found in the section called Long's well bore trajectory model and in the section called well bore stability survey model.

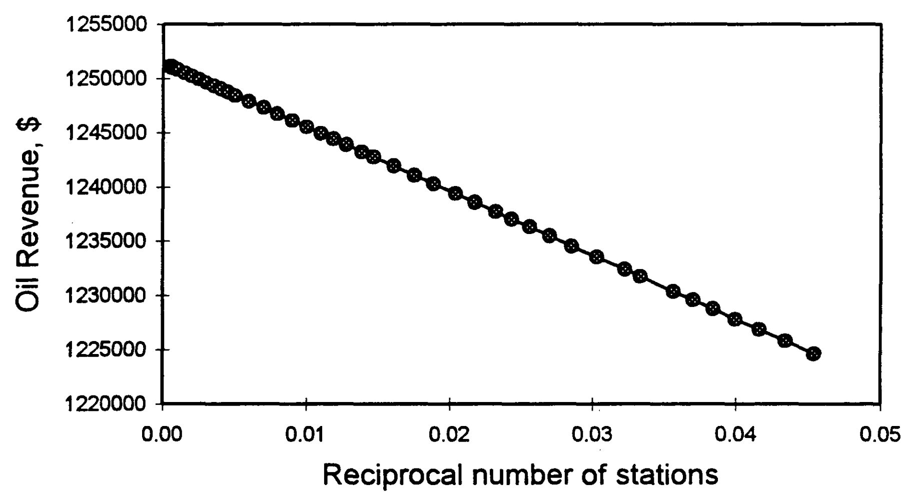

Figure 3. Oil Production Revenue of a Well

Figure 3 shows an example of a revenue for a directional well. The data for these examples are from the well DRL. As expected the revenue as computed with the petroleum production revenue model shows a continuous decrease in revenue with a reduction in the number of stations comprising an individual survey. While analyzing these figures it must be kept in mind that survey spacing increases to the right on the charts and the number of stations increase to the left. Figure 4 shows an example of survey costs for a directional well. The data for these examples are from the well DRL. As expected the costs as computed with the directional survey cost model shows a continuous increase in cost with the number of stations comprising an individual survey.

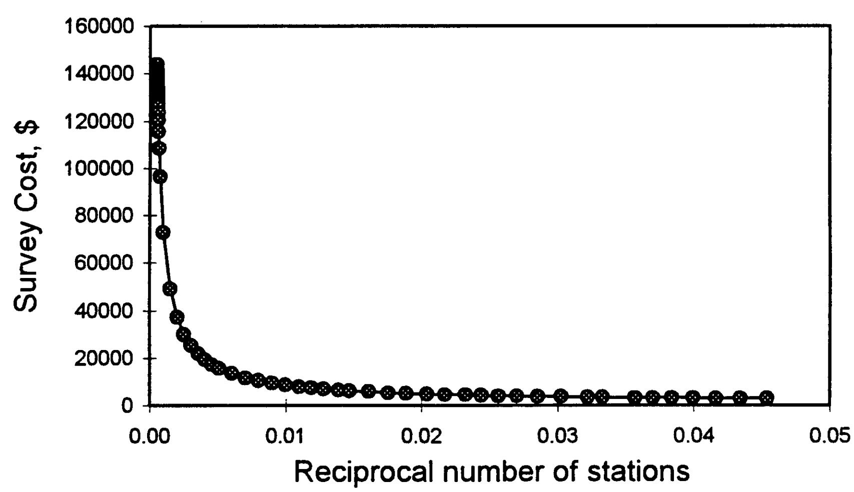

Figure 4. Survey Cost of a Well

Figure 5 is a combination of the computations from the two previous charts. It indicates that a maximum profit exists and that it exists for a single survey spacing. The optimum survey spacing for the this example which is well DRL occurs at the survey spacing value of 43 feet. This value corresponds the with value of reciprocal number of stations of 1/91. This means that had a survey been conducted which had 91 stations the maximum profit would have been realized for this well in regard to directional surveying.

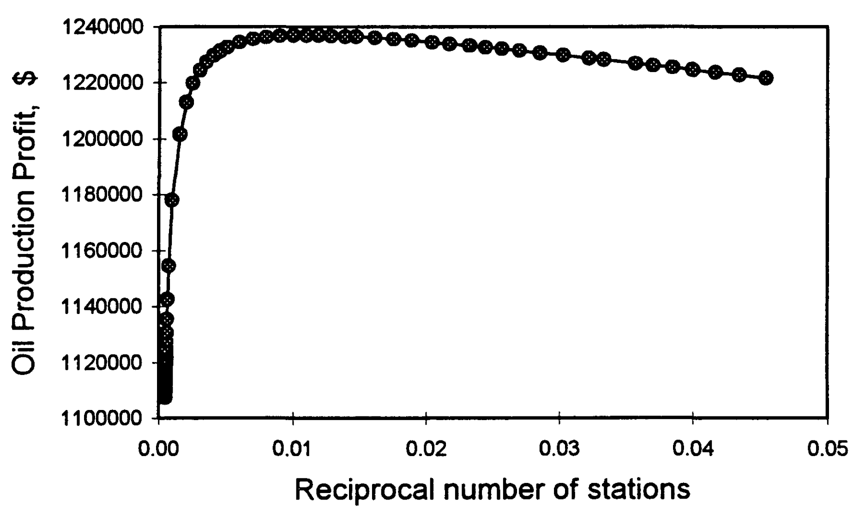

Figure 5. Oil Production Profit of a Well

3.3 Well Bore Survey Stability Model

Stability of a directional survey for a particular well depends on the nature of the survey. The value of stability can be expressed by computing the bottom hole displacements versus the reciprocal number of survey stations. In this research bottom hole displacements is the distance between the best bottom hole location and bottom hole locations computed with reduced surveys. Although this is not an complete definition of stability, it will suffice for this research.

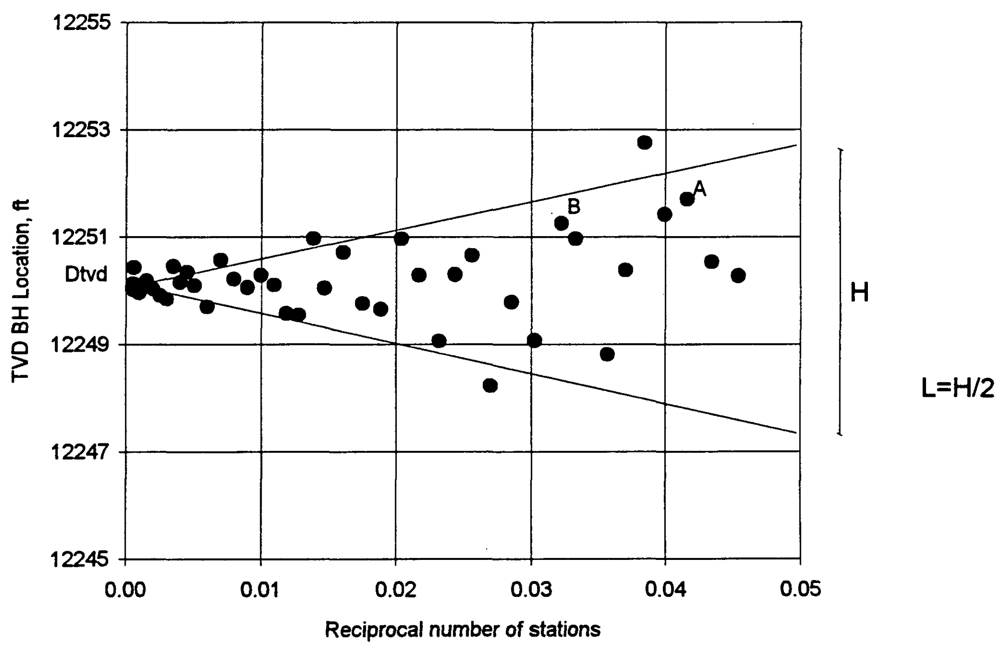

Figure 6. TVD Bottom Hole Location

Figure 6. is a plot of the True Vertical Depths (TVD) of the well DRL as computed with Long's model and reduced surveys versus the reciprocal number of surveys in each reduced survey. The variable, reciprocal number of stations, is employed so that the plotted points can be conveniently extrapolated to a value which would be produced by a survey containing an infinite number of surveys. The best bottom hole location is established by projecting the plotted points to the ordinate axis. In this example the projected TVD which is call the best TVD is 12,250.07 feet.

For example, point A and B as shown in figure 6 represent surveys containing 24 stations and 31 stations respectively. The plotted value of point A is 1/24 or 0.0417. The plotted value of point B is 1/31 or 0.032. Its corresponding TVD is 12,251.25 feet. This foregoing procedure can be applied for North/South and East/West bottom hole locations.

H is the length of the spread between the two lines which encompass the plotted points. H is a function of survey spacing. L is one-half the value of H. H_c is the value of H for the composite of the values of H for the

North/South and East/West coordinates. L_c is one-half the value of H_c.

3.4 The Computation Of The Variable L

The variable L_c is define, developed, and generated with the following procedure.

STEPS

1. Construct an East/West stability chart which is similar to figure 6 and is shown in figure B-3, as explained above.
2. Construct a North/South stability chart which is similar to figure 6 and is shown in figure B-2, as explained above.
3. Derive a composite bottom hole location with detailed in the following steps.
    a. With the North/South and East/West stability plots, figure B-2 and B-3, write the equations for the upper and lower boundary lines of the values of H as functions of $1/N_s$. In this research these lines were practically estimated. For the well DRL the equation only for the North/South upper boundary line is the following.

$$Y = 165.03 + 84.935 * X$$

where:

Y is ordinate value of the North/South coordinate location in feet.

X is abscissa value of the reciprocal number of stations ($1/N_s$).

b. Subtract the lower boundary equation from the upper boundary equation given in each figure. Call the resulting two functions $H_{N/S}$ and $H_{E/W}$. For the well DRL these two functions are the following.

$$H_{N/S} = 215.795 * 1/N_s$$

$$H_{E/W} = 191.635 * 1/N_s$$

c. Combine the two functions into a single function of $1/N_s$ with the following equation.

$$H_c = \sqrt{H_{N/S}^2 + H_{E/W}^2}$$

For the well DRL this function is the following function.

$$H_c = 288.603 * 1/N_s$$

d. Compute the values of L_c with the following formula.

$$L_c = \frac{H_c}{2}$$

For example for the well DRL the value of L_c for a reduced survey which has 22 is 6.559 feet.

Now, the values of L_c may be used in the petroleum production revenue model to compute revenues and eventually used to compute profits and survey spacing.

Figure 7 shows well bore stability (the ratio L/D versus the reciprocal number of stations). It is presented for the purpose of publishing typical values of stability for a real field well. Stability as depicted in figure 7 has an alternate definition which is the displacements divided by the best value of the particular directional parameter; i.e., L is the TVD displacement and D is the best TVD of the well.

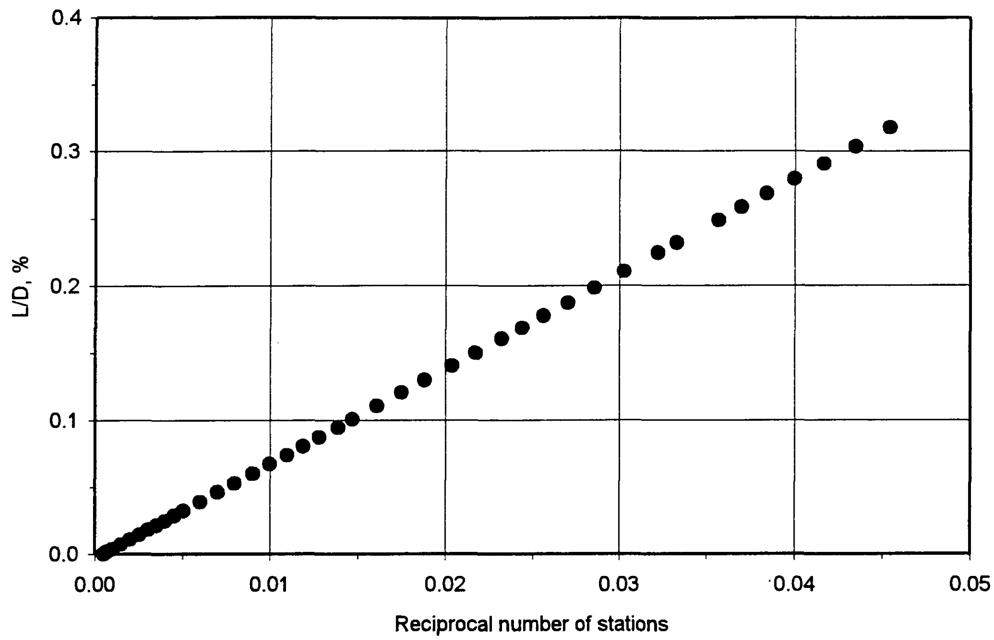

Figure 7. Well bore Stability

3.5 Long's Well Bore Trajectory Model

Long's computational trajectory model[13] which is based on an oblique circular arc is employed for the purpose of computing the bottom hole locations for the original survey data and all reduced surveys. Figure 8 shows the salient points of interest of the Long's method. The explanations of Long's model are as follows.

Suppose that a well has two survey stations, $S_1$and S_2 respectively, at the ends of a section of bore hole which forms a circular arc in an oblique plane, reside co-planar tangents, S_1-B and S_2-B to the bore hole.

Parameters known at point S_1 are measured depth, inclination, azimuth, true vertical depth, north and east coordinates. At point S_2, measured depth, inclination and azimuths are known. C is the center of curvature of the arc between S_1 and S_2 ; and ψ is the angle between the radii of the arc.

Long's working equations for ΔTVD, ΔN/S, ΔE/W, and DLS are written below.

$$\psi = 2 \operatorname{acos} [((1+\cos\phi \ \cos\phi_2+\sin\phi \ \sin\phi_2 \cos\Delta\theta)/2))]^{1/2} \tag{15}$$

$$\Delta TVD = \frac{180 \ \Delta MD \tan(\psi/2)}{\pi\psi} [\cos\phi_1+\cos\phi_2] \tag{16}$$

$$\Delta N/S = \frac{180 \ \Delta MD \tan(\psi/2)}{\pi\psi} [\sin\phi_1\cos\theta_1+\sin\phi_2\cos\theta_2] \tag{17}$$

$$\Delta E/W = \frac{180 \ \Delta MD \tan(\psi/2)}{\pi\psi} [\sin\phi_1\sin\theta_1+\cos\phi_2\cos\theta_2] \tag{18}$$

$$DLS = (200/\Delta MD)\,acos\,[((1+\cos\phi\ \cos\phi_2+\sin\phi\ \sin\phi_2\cos\Delta\theta)/2)]^{1/2} \qquad (19)$$

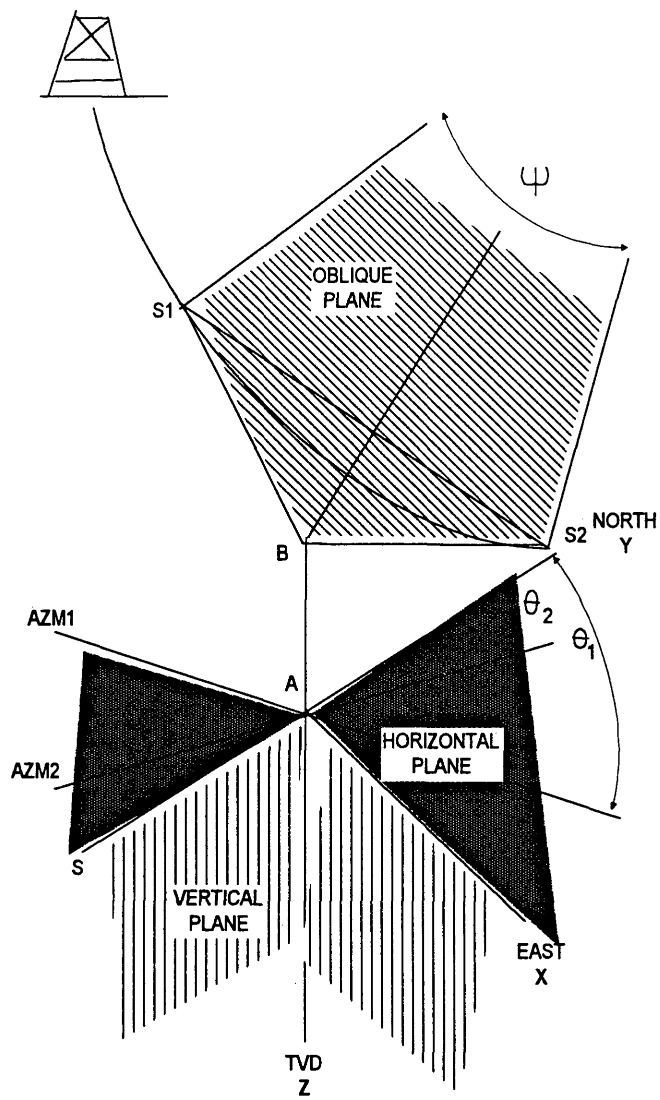

Figure 8. Long's Model[3]

The following example illustrates Long's trajectory transformation model.

Compute the displacements and dogleg severity between the two stations given in the table below[1].

St.No.	MD	I	Az	ΔN	ΔE	ΔTVD
31	900	10.75	225	---	---	---
32	950	13.50	231	21.55	31.95	82.65

The value of pertinent variables are

$\Delta MD = 950 - 900 = 50$

$\Delta\theta = 231 - 225 = 6°$

$\Delta\phi = 13.50 - 10.75 = 2.75°$

The dogleg severity DLS is

$$DLS = (200/50) acos\,[((1+\cos(10.75)\cos(13.5)+\sin(10.75)\sin(13.5)\cos(6))/2)]^{1/2}$$

$$DLS = 6.0429°/100ft$$

The turn angle of the arc ψ is

$\psi = 6.0429*50/100 = 3.0215°$

The displacement in the vertical direction ΔTVD is

$$\Delta TVD = \frac{180 * 50 * \tan(3.0215/2)}{\pi * 3.0215} [\cos(10.75)+\cos(13.5)] \quad (16)$$

ΔTVD = 48.88 feet

The North/South displacement $\Delta N/S$ is

$$\Delta N/S = \frac{180 * 50 * \tan(3.03215/2)}{\pi * 3.0125} [\sin(10.75)\cos(225)+\sin(13.5)\cos(221)] \quad (17)$$

$\Delta N/S$ = -6.97 feet

The East/West displacement $\Delta E/W$ is

$$\Delta E/W = \frac{180 * 50 * \tan(3.0215/2)}{\pi * 3.0215} [\sin(10.75)\sin(225)+\cos(13.5)\cos(231)] \quad (18)$$

$\Delta E/W$ = -7.83 feet

Further explanation of Long's method is presented in his paper[13].

Chapter 4

DISCUSSION OF THE RESULTS

4.1 Well DRL

The partial directional survey of well DRL is near ideal for the research required for the explanation and illustration of the directional survey spacing model. The survey data are presented in Table C-1 and are shown as plotted points of the stations in figures A-1 and A-2. The survey begins at a measured depth of 8,867.51 feet and ends at a measured depth of 12,784.26 feet. The survey contains 1,958 survey stations with a spacing of 2 feet. These two properties allow many reduced surveys to be generated by the systematic survey deletion technique. These numerous reduced surveys define a populated profit plot which allows the selection of the optimum survey spacing to be very precise. Also the survey's length of 3,916.75 feet is sufficient, as are its one major turn and straight section, to be convincing of its practicality. Table C-5 contains the many and varied computations for the well DRL. The optimum well spacing for the well DRL was computed to be

46.628 feet. This value is well within the practical range of field surveying techniques and is reasonable and viable.

4.2 Well DBM

The directional survey of the well DBM may be typical of many field wells. The survey data are presented in Table C-3 and are shown as plotted points of the stations in figures A-3 and A-4. The well bore does have a major turn and a straight portion. Its directional survey has 288 stations over a well bore length of 6,170 feet and has a spacing of 100 feet from the surface to 3,000.30 feet, a spacing of 50 feet from 3,000 feet to 3,700.20 feet, and a spacing of 10 feet from 3,700.20 to 6,170 feet. Table C-6 contains the many and varied computations for the well DBM. The optimum well spacing for the well DBM was computed to be 28.433 feet. This value is well within the practical range of field surveying techniques and is, also, reasonable and viable.

Chapter 5

CONCLUSIONS

From previous works and discussion of the results, the conclusions are as follows.

1. A rigorous optimum spacing selection model which is based on the stability of directional surveys was written and illustrated.
2. A method of accurately locating the bottom hole location of a well bore was illustrated and described.

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NOMENCLATURE

B_o = Formation volume factor, fraction

HP = Hydrocarbon production, STB

h = Height of the hydrocarbon reservoir, ft

PC = Hydrocarbon value per STB, $/STB

R, R_c = Radius of a circular hydrocarbon reservoir, ft subscript $_c$ for composite at a particular survey station

R_f = Hydrocarbon recovery factor, fraction

S_w = Water saturation within the porosity of the reservoir rock, fraction

$\varnothing$ = Porosity of the rock within the reservoir boundary, fraction

1 acre-ft = 7758 bbl

1 acre-ft = 43560 ft^3

L, L_c = Distance from the center of the reservoir, ft subscript $_c$ for a composite at particular station

RT = Rig Time, hour

RC = Rig Cost, $/hour

Ftc = Fishing tool cost, \$/day

MWDt = Measurement While Drilling Tool Cost, \$/day

FC = Fishing Cost, \$

ST = Sidetracking Cost, \$

TC = Tools Cost, \$/day

CC = Cementing Cost, \$/day

Apc = Processing of Abandonment Cost, \$

AC = Abandoning Cost, \$

TBC = Trouble Cost, \$

PS = Preparation for survey cost, \$

MWDR = MWD Rental, \$

NTC = No Trouble Cost, \$

SC = Survey Cost, \$

TVD = True Vertical Depth, ft

N/S = North/South direction, ft

E/W = East/West direction, ft

BH = Bottom Hole, sometimes used together with TVD, N/S, and E/W directions

MD = Measured Depth, ft

DLS = Dog Leg Severity, ft

Δ = Delta

π = pi, 3.14159

ϕ = Inclination, degree

I = Inclination, degree

$\varnothing$ = Azimuth, degree

Az = Azimuth, degree

St.No= Station number

ψ = Angle between the radii, degree

C = Center of curvature between S_1 and S_2

S_1, S_2 = Survey station at point 1 and point 2

K = Selected point on the circular arc between S_1 and S_2

N_s = Number of stations

$1/N_s$ = Reciprocal number of station

$D, D_{TVD}, D_{NS}, D_{EW}, D_c$ = The best bottom hole location, ft subscripts $_{TVD}$, $_{Ns}$, $_{Ew}$ and $_c$ for true vertical depth, north/south direction, east/west direction and composite respectively

$H, H_{TVD}, H_{N/S}, H_{E/W}, H_c$ = The length of the spread between the two lines which encompass the plotted points, ft, subscripts $_{N/S}$, $_{E/W}$, $_c$, $_{TVD}$ for North/South, East/West, a composite and True Vertical Depth.

Rev = Revenue, $

APPENDIX A

WELL BORE TRAJECTORY PROFILES

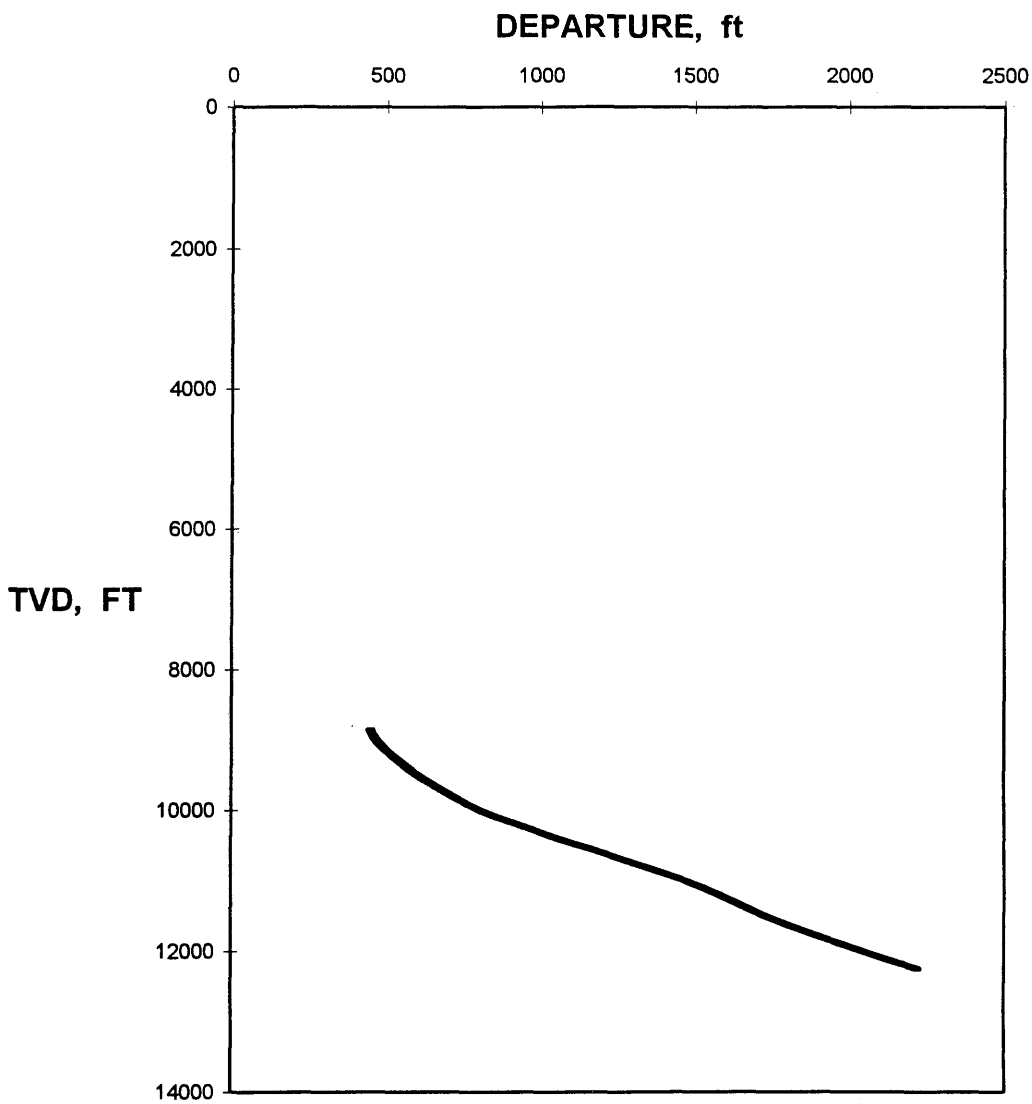

Figure A-1. Section View of the well DRL

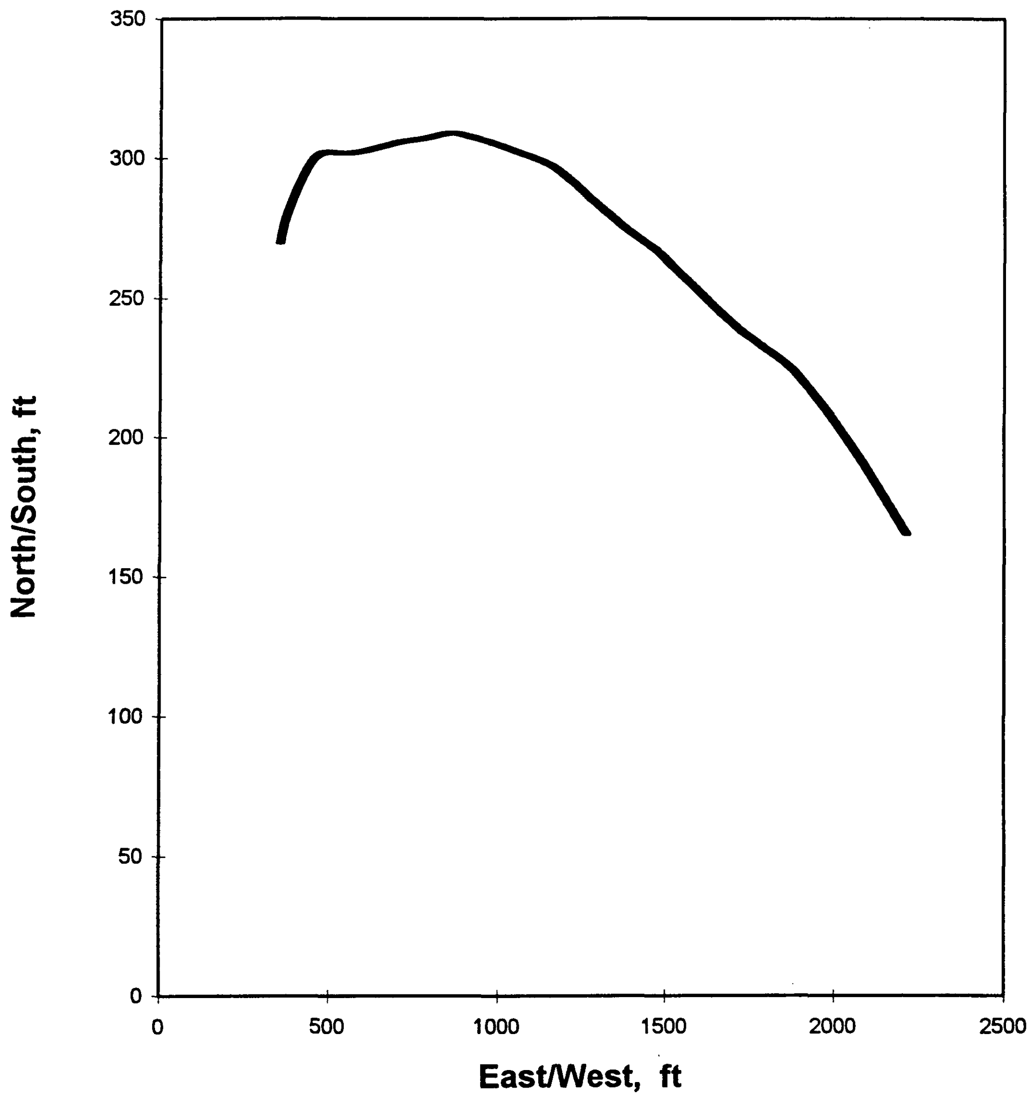

Figure A-2. Plane View of the well DRL

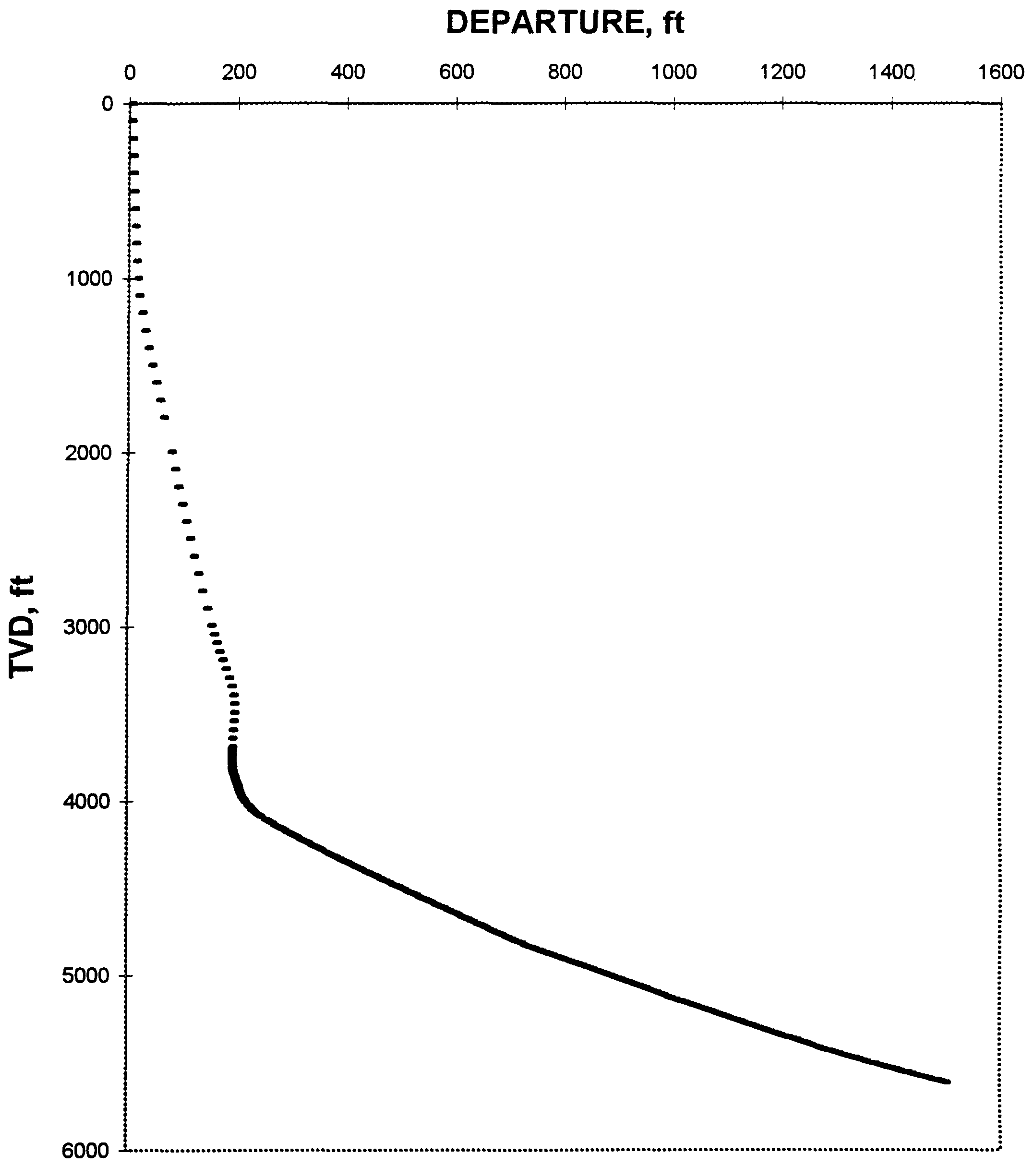

Figure A-3. Section View of the well DBM

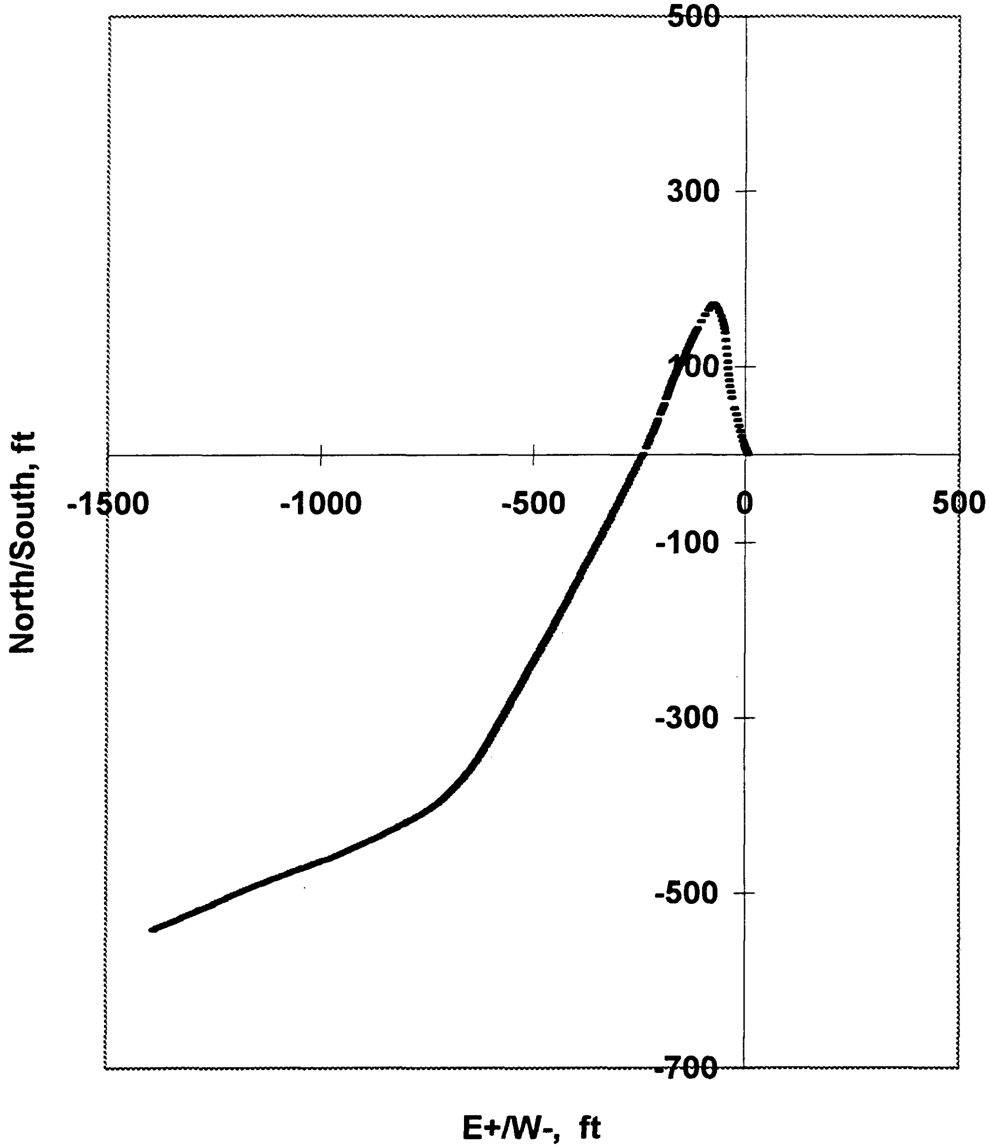

Figure A-4. Plane View of the well DBM

APPENDIX B

STABILITY BOTTOM HOLE LOCATIONS

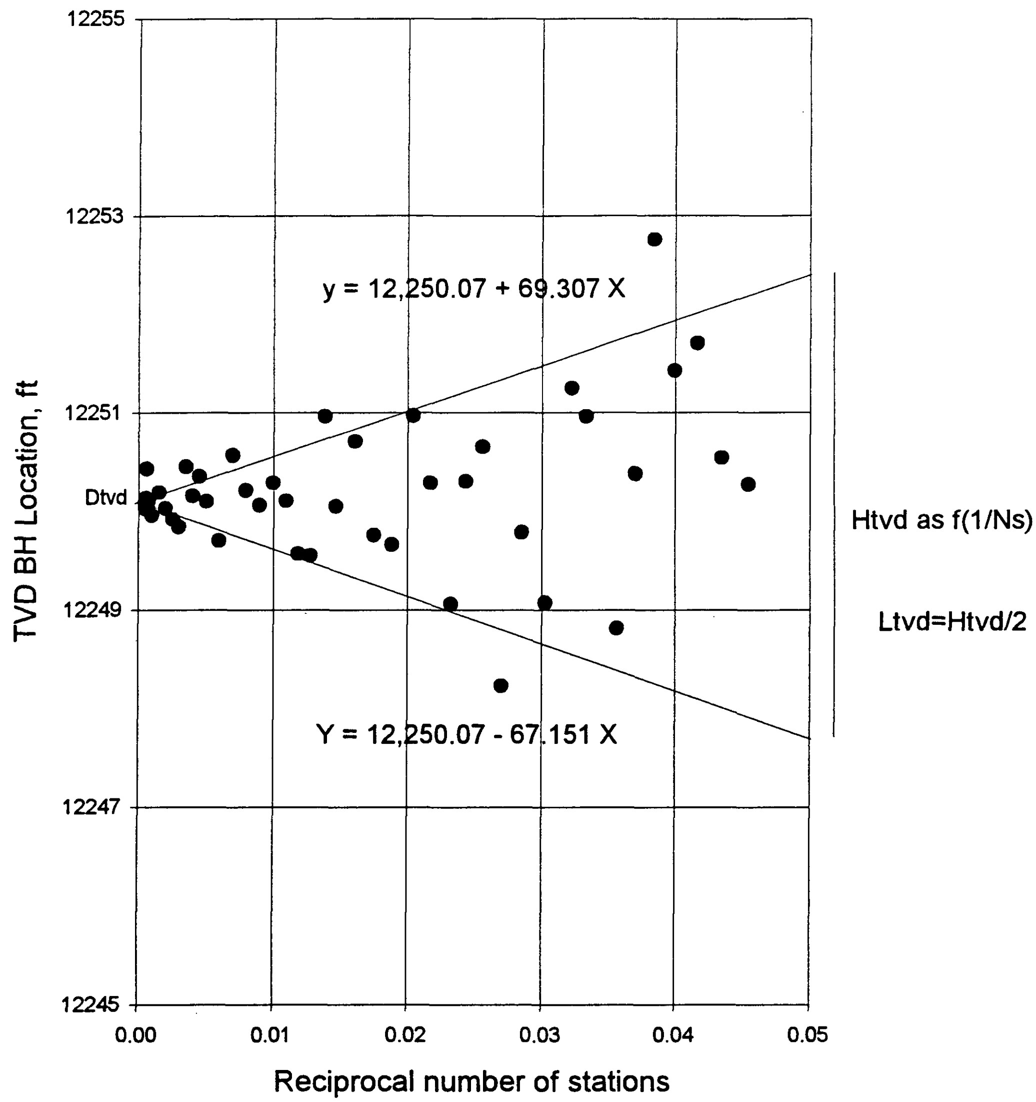

Figure B-1. TVD Bottom Hole Location of The Well DRL

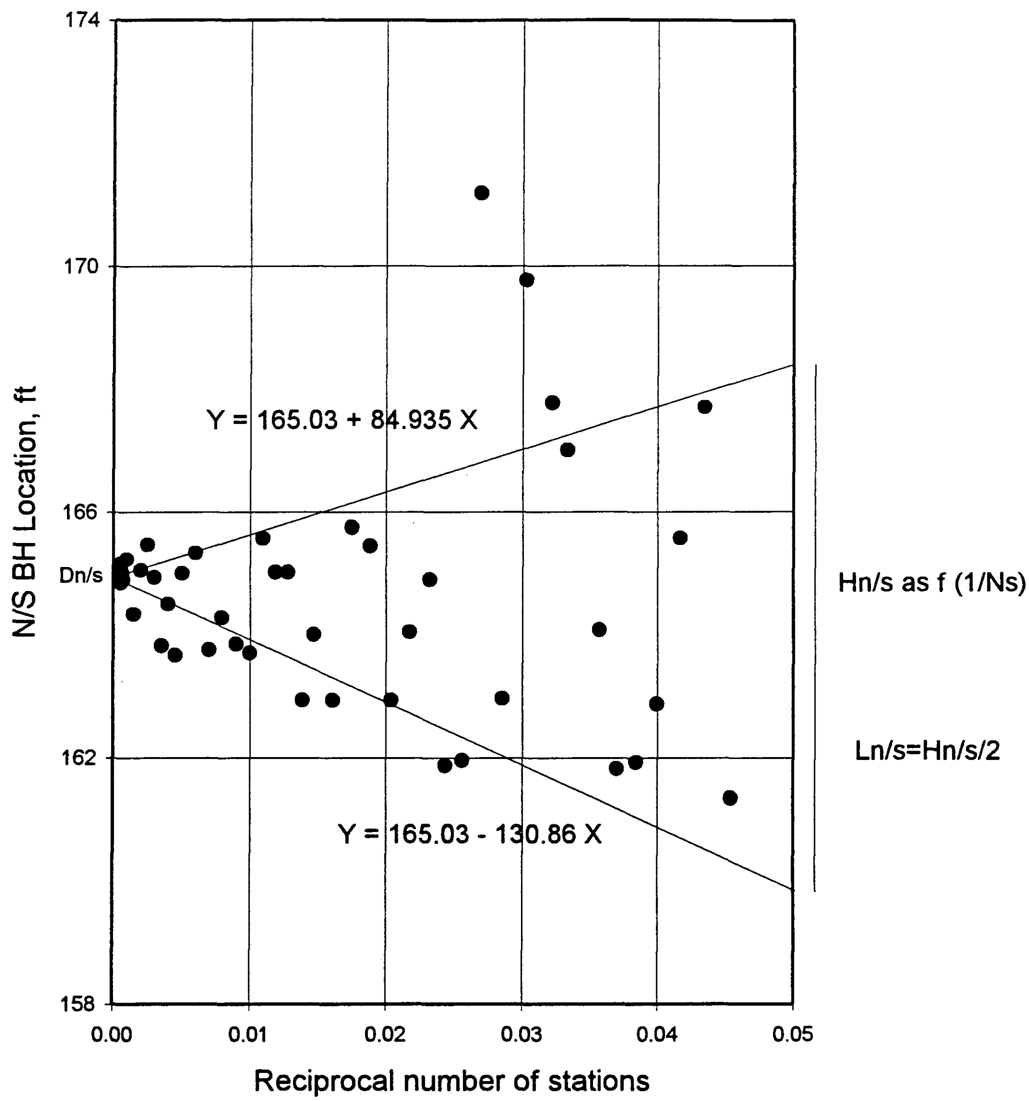

Figure B-2. North/South Bottom Hole Location of The Well DRL

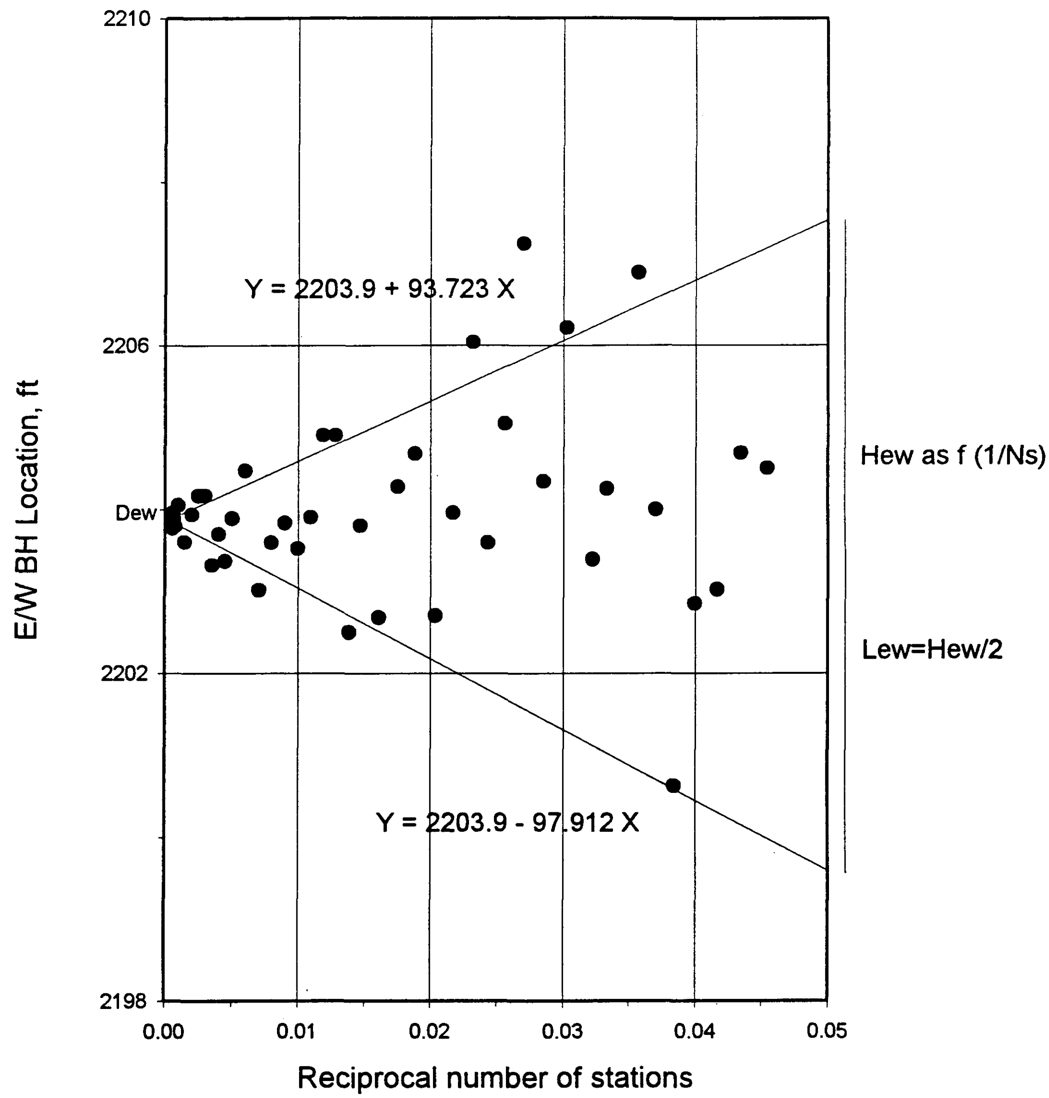

Figure B-3. East/West Bottom Hole Location of The Well DRL

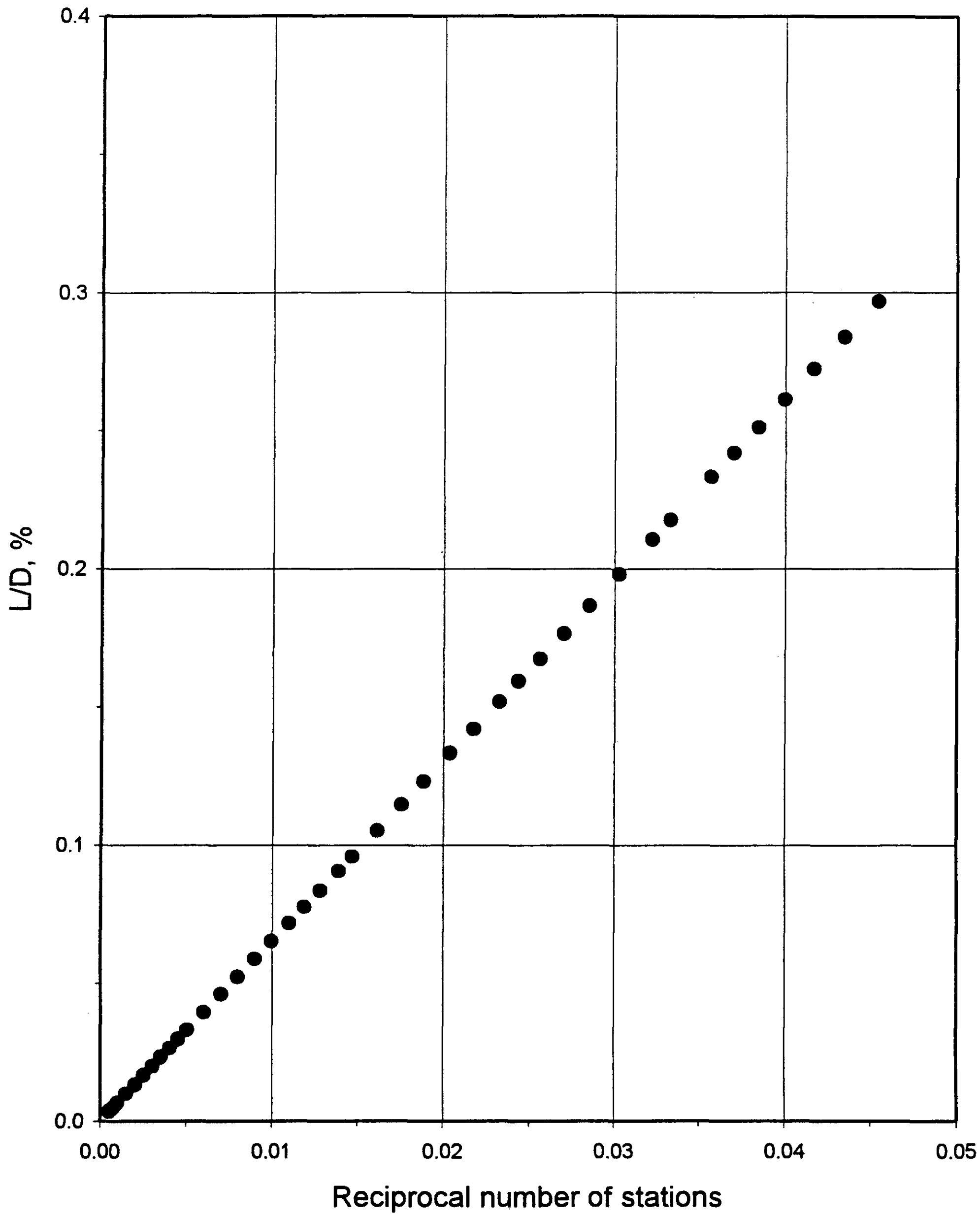

Figure B-4. Stability of The Well DRL

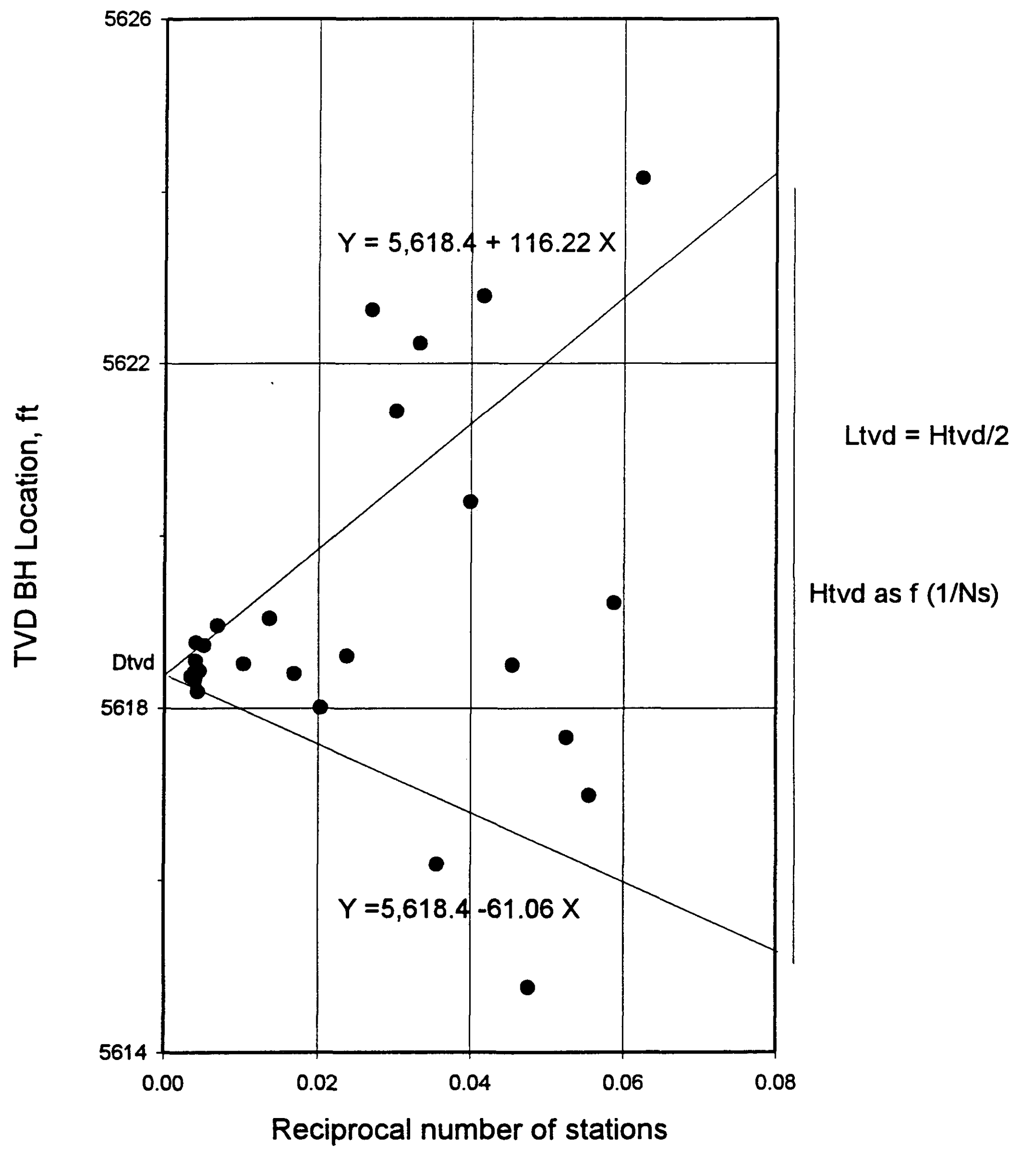

Figure B-5. TVD Bottom Hole Location of The Well DBM

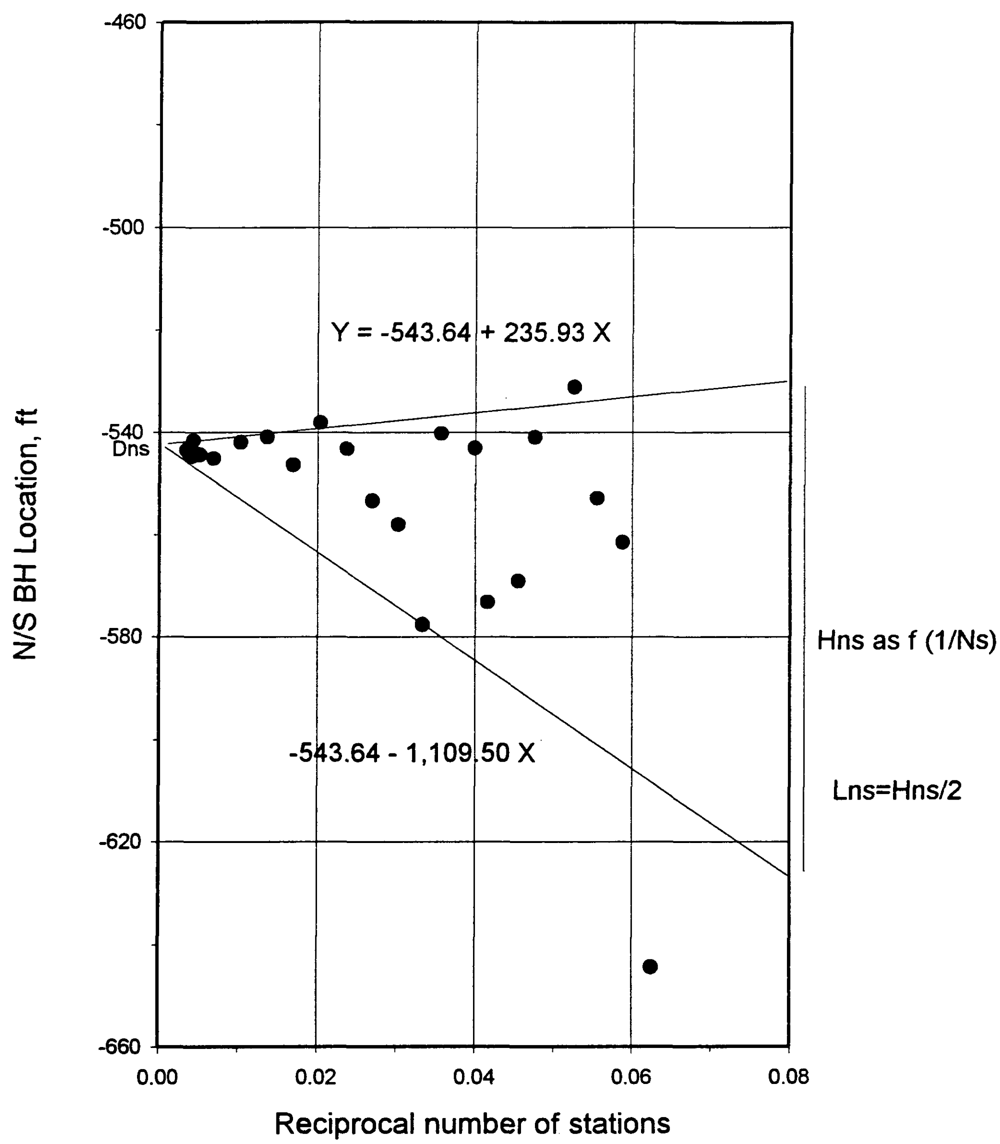

Figure B-6. North/South Bottom Hole Location of The Well DBM

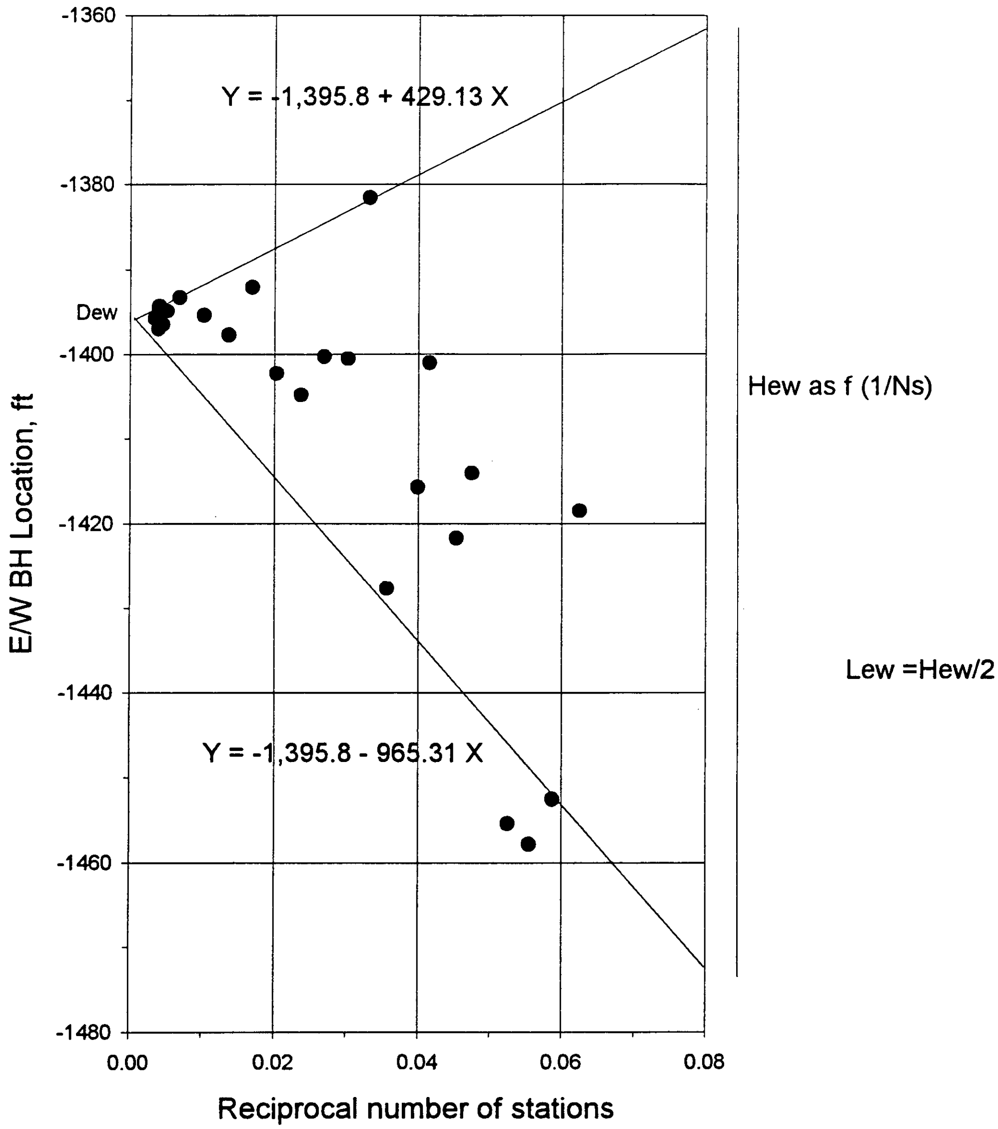

Figure B-7. East/West Bottom Hole Location of The Well DBM

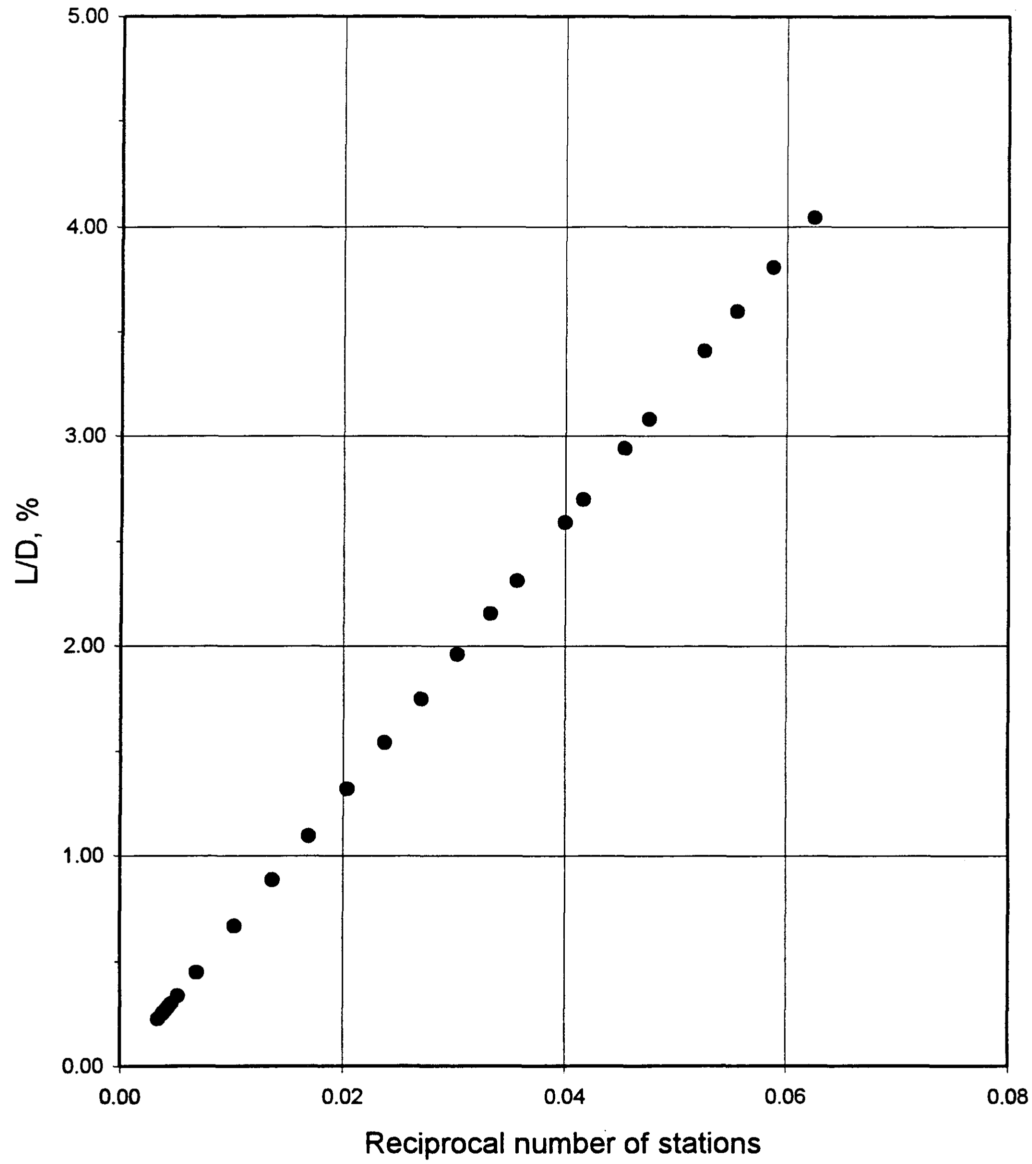

Figure B-8. Stability of The Well DBM

APPENDIX C

DATA PROCESSING

Table C-1

Original Data of the Well DRL

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
			8945.51	7.53	62.02	9025.51	10.71	69.58
8867.51	5.67	52.02	8947.51	7.64	61.45	9027.51	10.71	70.05
8869.51	5.68	51.35	8949.51	7.82	61.74	9029.51	10.76	70.68
8871.51	5.72	53.01	8951.51	7.73	62.09	9031.51	10.98	69.91
8873.51	6.05	51.13	8953.51	7.82	63.09	9033.51	11.10	70.52
8875.51	5.94	53.36	8955.51	7.83	62.93	9035.51	11.25	70.28
8877.51	5.93	53.47	8957.51	8.10	62.41	9037.51	11.33	70.30
8879.51	5.92	55.63	8959.51	8.05	62.85	9039.51	11.50	70.06
8881.51	6.00	57.03	8961.51	8.14	64.05	9041.51	11.51	71.22
8883.51	6.00	55.06	8963.51	8.12	64.83	9043.51	11.47	71.02
8885.51	5.97	55.72	8965.51	8.42	64.51	9045.51	11.59	71.54
8887.51	6.01	55.65	8967.51	8.63	64.47	9047.51	11.57	72.60
8889.51	6.09	55.63	8969.51	8.29	65.35	9049.51	11.73	71.76
8891.51	6.23	57.50	8971.51	8.61	65.29	9051.51	11.79	72.32
8893.51	6.16	56.13	8973.51	8.64	64.97	9053.51	11.97	72.05
8895.51	6.35	57.32	8975.51	8.73	65.47	9055.51	12.05	71.90
8897.51	6.29	55.94	8977.51	8.73	65.22	9057.51	11.96	72.01
8899.51	6.31	57.98	8979.51	8.77	66.74	9059.51	12.09	72.61
8901.51	6.71	54.62	8981.51	8.80	66.51	9061.51	12.02	73.25
8903.51	6.26	57.20	8983.51	8.99	66.68	9063.51	12.14	72.31
8905.51	6.32	59.28	8985.51	8.93	66.76	9065.51	12.07	72.69
8907.51	6.45	58.02	8987.51	9.11	66.81	9067.51	12.33	73.00
8909.51	6.45	57.54	8989.51	9.15	67.15	9069.51	12.43	72.31
8911.51	6.37	58.95	8991.51	9.24	68.10	9071.51	12.49	72.55
8913.51	6.45	57.91	8993.51	9.28	66.37	9073.51	12.50	72.69
8915.51	6.56	57.93	8995.51	9.26	67.75	9075.51	12.63	72.47
8917.51	6.57	59.15	8997.51	9.41	67.90	9077.51	12.56	72.94
8919.51	6.64	58.47	8999.51	9.32	68.90	9079.51	12.72	72.52
8921.51	6.66	60.43	9001.51	9.53	68.83	9081.51	12.74	72.54
8923.51	6.85	58.05	9003.51	9.57	69.40	9083.51	12.81	72.58
8925.51	6.77	60.34	9005.51	9.72	67.85	9085.51	12.88	72.65
8927.51	6.92	59.00	9007.51	9.94	69.06	9087.51	12.92	72.78
8929.51	6.98	59.02	9009.51	10.03	68.33	9089.51	13.04	72.41
8931.51	6.90	59.00	9011.51	9.85	69.07	9091.51	13.03	72.72
8933.51	7.03	59.33	9013.51	10.10	69.69	9093.51	13.19	72.74
8935.51	6.97	59.92	9015.51	10.05	70.41	9095.51	13.26	73.12
8937.51	7.09	60.42	9017.51	10.17	69.03	9097.51	13.26	73.28
8939.51	7.27	61.15	9019.51	10.14	69.96	9099.51	13.46	72.60
8941.51	7.53	59.20	9021.51	10.33	69.97	9101.51	13.22	72.41
8943.51	7.54	60.31	9023.51	10.58	69.99	9103.51	13.55	73.26

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
9105.51	13.51	72.90	9185.51	15.97	75.64	9266.26	16.72	77.63
9107.51	13.80	73.02	9187.51	15.53	76.14	9268.26	17.01	76.73
9109.51	13.90	72.64	9189.51	16.03	75.68	9270.26	16.56	79.21
9111.51	14.03	72.60	9191.51	15.84	75.72	9272.26	16.86	77.89
9113.51	14.28	72.79	9193.51	15.72	76.05	9274.26	17.03	77.87
9115.51	14.20	72.98	9195.51	15.93	75.81	9276.26	17.08	77.78
9117.51	14.07	73.60	9198.26	15.89	75.67	9278.26	17.15	77.69
9119.51	14.23	73.43	9200.26	16.01	75.29	9280.26	16.91	78.57
9121.51	14.29	73.64	9202.26	15.85	75.92	9282.26	17.00	78.35
9123.51	14.27	74.00	9204.26	15.98	75.70	9284.26	17.02	78.24
9125.51	14.62	72.77	9206.26	15.92	75.91	9286.26	17.22	78.44
9127.51	14.41	73.07	9208.26	15.98	75.88	9288.26	17.23	78.53
9129.51	14.56	74.13	9210.26	16.02	75.70	9290.26	17.10	79.06
9131.51	14.76	72.65	9212.26	16.03	75.32	9292.26	17.46	78.47
9133.51	14.83	72.67	9214.26	15.99	76.25	9294.26	17.45	78.52
9135.51	14.51	74.36	9216.26	16.05	75.86	9296.26	17.53	78.56
9137.51	14.91	74.48	9218.26	16.12	75.54	9298.26	17.43	78.88
9139.51	14.90	74.57	9220.26	16.20	75.99	9300.51	17.50	79.13
9141.51	14.96	74.26	9222.26	16.03	76.09	9302.51	17.26	79.68
9143.51	14.99	74.88	9224.26	16.23	75.97	9304.51	17.50	79.87
9145.51	15.18	73.68	9226.26	16.17	76.04	9306.51	17.61	79.23
9147.51	15.28	74.35	9228.26	15.93	76.47	9308.51	17.54	79.79
9149.51	15.44	74.22	9230.26	16.20	76.11	9310.51	17.68	79.68
9151.51	15.20	74.14	9232.26	16.12	76.96	9312.51	17.59	80.10
9153.51	14.98	73.77	9234.26	16.28	76.59	9314.51	17.67	79.97
9155.51	15.40	74.86	9236.26	16.32	76.13	9316.51	17.60	80.08
9157.51	15.31	75.19	9238.26	16.41	76.67	9318.51	17.56	80.63
9159.51	15.33	75.02	9240.26	16.44	76.73	9320.51	17.50	81.02
9161.51	15.54	75.66	9242.26	16.33	76.67	9322.51	17.71	80.57
9163.51	15.34	74.64	9244.26	16.47	76.66	9324.51	17.60	81.06
9165.51	15.37	74.83	9246.26	16.64	76.46	9326.51	17.70	81.15
9167.51	15.61	75.23	9248.26	16.44	77.26	9328.51	17.75	81.13
9169.51	15.67	74.41	9250.26	16.47	76.88	9330.51	17.72	81.39
9171.51	15.70	74.99	9252.26	16.48	77.60	9332.51	17.61	81.82
9173.51	15.49	76.07	9254.26	16.25	78.39	9334.51	17.60	82.18
9175.51	15.76	76.40	9256.26	16.58	77.68	9336.51	17.83	81.69
9177.51	15.77	75.71	9258.26	16.79	77.27	9338.51	17.84	81.85
9179.51	15.85	74.86	9260.26	16.57	77.38	9340.51	17.82	82.19
9181.51	15.96	75.39	9262.26	16.79	77.73	9342.51	17.93	81.75
9183.51	15.80	75.30	9264.26	16.89	77.61	9344.51	17.77	82.55

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
9346.51	17.87	82.44	9426.76	18.79	87.44	9506.76	20.42	90.90
9348.51	17.86	82.76	9428.76	18.74	87.43	9508.76	20.49	90.61
9350.51	17.77	83.03	9430.76	19.00	87.24	9510.76	20.41	91.06
9352.51	17.82	83.11	9432.76	18.76	87.80	9512.76	20.43	91.18
9354.51	17.86	83.15	9434.76	18.80	87.72	9514.76	20.66	90.59
9356.51	17.85	83.50	9436.76	18.75	87.79	9516.76	20.35	91.54
9358.51	17.86	83.62	9438.76	18.94	87.04	9518.76	20.62	91.21
9360.51	17.77	83.95	9440.76	19.01	87.86	9520.76	20.63	90.91
9362.51	17.76	84.36	9442.76	18.91	88.41	9523.01	20.70	90.85
9364.51	17.79	84.55	9444.76	19.10	87.98	9525.01	20.68	90.87
9366.51	17.86	84.29	9446.76	19.13	87.44	9527.01	20.76	90.93
9368.51	17.91	84.52	9448.76	19.03	88.88	9529.01	20.73	91.50
9370.51	17.77	85.03	9450.76	19.15	88.37	9531.01	20.95	90.64
9372.51	17.91	84.79	9452.76	19.23	88.44	9533.01	21.02	90.47
9374.51	17.89	85.14	9454.76	19.18	88.73	9535.01	21.12	90.22
9376.51	17.91	85.31	9456.76	19.26	88.69	9537.01	20.94	90.98
9378.51	17.97	85.25	9458.76	19.40	88.98	9539.01	21.35	89.92
9380.51	17.98	85.30	9460.76	19.44	89.00	9541.01	21.34	90.37
9382.51	18.09	85.07	9462.76	19.42	89.38	9543.01	21.33	90.34
9384.51	18.07	85.63	9464.76	19.50	89.86	9545.01	21.38	90.51
9386.76	18.09	85.65	9466.76	19.53	89.66	9547.01	21.47	90.30
9388.76	18.23	85.89	9468.76	19.69	89.86	9549.01	21.46	90.50
9390.76	18.02	86.32	9470.76	19.68	89.56	9551.01	21.56	90.06
9392.76	17.83	86.97	9472.76	19.71	89.99	9553.01	21.71	90.15
9394.76	18.20	86.50	9474.76	19.76	90.12	9555.01	21.74	90.35
9396.76	18.16	86.58	9476.76	19.74	90.36	9557.01	21.74	90.60
9398.76	18.51	86.58	9478.76	19.91	90.44	9559.01	21.93	90.16
9400.76	18.40	86.61	9480.76	19.86	90.56	9561.01	21.84	91.15
9402.76	18.40	86.50	9482.76	19.99	90.74	9563.01	22.12	89.58
9404.76	18.30	86.90	9484.76	19.96	90.64	9565.01	22.20	89.85
9406.76	18.32	87.22	9486.76	20.08	90.55	9567.01	22.23	90.33
9408.76	18.17	87.90	9488.76	20.10	90.58	9569.01	22.38	90.02
9410.76	18.28	87.74	9490.76	20.16	90.69	9571.01	22.12	91.09
9412.76	18.30	87.59	9492.76	20.10	91.01	9573.01	22.39	90.16
9414.76	18.19	88.27	9494.76	20.11	91.11	9575.01	22.26	91.01
9416.76	18.44	87.33	9496.76	20.00	91.58	9577.01	22.34	90.61
9418.76	18.44	87.94	9498.76	20.17	90.71	9579.01	22.41	90.31
9420.76	18.53	87.55	9500.76	20.34	90.47	9581.01	22.50	90.78
9422.76	18.46	87.87	9502.76	20.26	90.92	9583.01	22.61	90.88
9424.76	18.49	87.91	9504.76	20.34	90.72	9585.01	22.91	89.42

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
9587.01	22.75	90.15	9667.01	23.28	90.16	9747.26	23.18	88.72
9589.01	22.71	90.58	9669.01	23.36	89.55	9749.26	23.10	88.73
9591.01	23.02	89.90	9671.01	23.36	89.43	9751.26	23.12	88.70
9593.01	22.93	89.95	9673.01	23.35	89.52	9753.26	23.14	88.34
9595.01	22.94	90.45	9675.01	23.29	89.56	9755.26	23.16	88.63
9597.01	22.98	90.22	9677.01	23.27	89.41	9757.26	23.16	88.64
9599.01	23.09	90.03	9679.01	23.31	89.37	9759.26	23.11	88.69
9601.01	23.05	90.21	9681.01	23.38	89.29	9761.26	23.09	88.65
9603.01	23.19	90.15	9683.01	23.40	89.19	9763.26	23.07	88.61
9605.01	23.11	90.16	9685.01	23.27	89.25	9765.26	23.12	88.54
9607.01	23.22	90.19	9687.01	23.32	89.12	9767.26	23.10	88.58
9609.01	23.27	89.80	9689.01	23.28	89.18	9769.26	23.00	88.89
9611.01	23.17	90.59	9691.01	23.14	89.40	9771.26	23.24	88.22
9613.01	23.15	90.31	9693.01	23.27	88.98	9773.26	23.09	88.70
9615.01	23.21	90.23	9695.01	23.28	88.80	9775.26	23.13	88.44
9617.01	23.23	90.05	9697.01	23.25	88.95	9777.26	23.23	88.31
9619.01	23.20	90.25	9699.01	23.17	89.23	9779.26	23.18	88.47
9621.01	23.27	90.17	9701.01	23.07	89.31	9781.26	23.44	87.64
9623.01	23.28	90.24	9703.01	23.21	89.04	9783.26	23.24	88.25
9625.01	23.37	89.97	9705.01	23.23	88.89	9785.26	23.19	88.36
9627.01	23.40	89.70	9707.01	23.27	89.05	9787.26	23.02	88.89
9629.01	23.30	89.96	9709.01	23.13	89.08	9789.26	23.26	88.13
9631.01	23.41	89.75	9711.01	23.14	89.03	9791.26	23.16	88.43
9633.01	23.45	89.36	9713.01	23.12	89.07	9793.26	23.29	88.05
9635.01	23.71	88.84	9715.01	23.18	88.83	9795.26	23.21	88.40
9637.01	23.72	88.84	9717.01	23.24	88.73	9797.26	23.15	88.47
9639.01	23.53	89.39	9719.01	23.16	88.94	9799.26	23.22	88.27
9641.01	23.44	89.54	9721.01	23.15	88.92	9801.26	23.24	88.36
9643.01	23.21	90.01	9723.01	23.10	89.06	9803.26	23.21	88.38
9645.01	23.31	89.58	9725.01	23.05	89.15	9805.26	23.28	88.26
9647.01	23.28	89.63	9727.01	23.20	88.78	9807.26	23.28	88.38
9649.01	23.48	89.24	9729.01	23.26	88.50	9809.26	23.21	88.52
9651.01	23.42	89.38	9731.26	23.22	88.35	9811.26	23.19	88.76
9653.01	23.40	89.39	9733.26	23.18	88.52	9813.26	23.05	89.02
9655.01	23.32	89.52	9735.26	23.21	88.47	9815.26	22.99	88.88
9657.01	23.25	89.70	9737.26	23.30	88.58	9817.26	23.33	88.28
9659.01	23.24	89.71	9739.26	23.09	88.96	9819.26	23.53	87.89
9661.01	23.40	89.39	9741.26	23.19	88.67	9821.26	23.53	87.74
9663.01	23.29	89.52	9743.26	23.21	88.56	9823.26	23.43	88.16
9665.01	23.51	89.10	9745.26	23.24	88.51	9825.26	23.41	87.98

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
9827.26	23.38	88.48	9907.26	24.33	88.63	9987.26	25.30	88.34
9829.26	23.52	88.04	9909.26	24.57	87.92	9989.26	25.25	88.58
9831.26	23.57	88.10	9911.26	24.66	88.07	9991.26	25.35	88.42
9833.26	23.46	88.39	9913.26	24.54	88.28	9993.26	25.39	88.38
9835.26	23.55	88.20	9915.26	24.48	88.43	9995.26	25.48	88.19
9837.26	23.59	87.93	9917.26	24.60	88.10	9997.26	25.42	88.43
9839.26	23.40	88.72	9919.26	24.56	88.43	9999.26	25.46	88.26
9841.26	23.61	88.30	9921.26	24.69	88.02	10001.26	25.56	88.05
9843.26	23.60	88.17	9923.26	24.69	88.24	10003.26	25.61	88.29
9845.26	23.67	88.02	9925.26	24.65	88.27	10005.26	25.52	88.70
9847.26	23.64	88.28	9927.26	24.60	88.40	10007.26	25.63	88.38
9849.26	23.71	88.27	9929.26	24.64	88.41	10009.26	25.70	88.25
9851.26	23.75	88.31	9931.26	24.76	88.18	10011.26	25.65	88.57
9853.26	23.76	88.30	9933.26	24.71	88.09	10013.26	25.85	88.15
9855.26	23.78	88.37	9935.26	24.69	88.28	10015.26	25.75	88.74
9857.26	23.81	88.34	9937.26	24.73	88.20	10017.26	25.80	88.51
9859.26	23.89	88.32	9939.26	24.80	88.33	10019.26	25.76	88.70
9861.26	23.94	88.08	9941.26	25.09	88.46	10021.26	25.77	88.71
9863.26	24.04	87.96	9943.26	24.86	88.17	10023.26	26.03	88.34
9865.26	23.98	88.07	9945.26	24.86	88.46	10025.26	25.96	88.44
9867.26	24.01	88.05	9947.26	24.92	88.24	10027.26	26.07	88.59
9869.26	24.02	88.24	9949.26	25.07	87.89	10029.26	26.12	88.49
9871.26	23.93	88.54	9951.26	24.83	88.48	10031.26	26.07	88.84
9873.26	24.02	88.46	9953.26	24.79	88.59	10033.26	26.12	88.83
9875.26	24.15	88.21	9955.26	24.93	88.29	10035.26	26.18	88.85
9877.26	24.13	87.96	9957.26	25.38	87.41	10037.26	26.25	88.93
9879.26	24.11	88.15	9959.26	25.05	88.22	10039.26	26.23	89.02
9881.26	24.13	88.24	9961.26	25.01	88.33	10041.26	26.38	88.73
9883.26	24.17	88.38	9963.26	25.18	88.20	10043.26	26.42	88.87
9885.26	24.20	88.22	9965.26	25.11	88.22	10045.26	26.48	89.01
9887.26	24.19	88.27	9967.26	25.10	88.33	10047.26	26.44	89.17
9889.26	24.16	88.39	9969.26	25.17	88.09	10049.26	26.60	88.87
9891.26	24.30	87.97	9971.26	25.41	87.55	10051.26	26.68	88.79
9893.26	24.33	88.14	9973.26	25.18	88.19	10053.26	26.73	88.85
9895.26	24.40	88.08	9975.26	25.16	88.34	10055.26	26.83	88.88
9897.26	24.37	88.21	9977.26	25.18	88.19	10057.26	26.84	89.01
9899.26	24.28	88.39	9979.26	25.26	88.45	10059.26	26.77	89.39
9901.26	24.46	88.25	9981.26	25.27	88.27	10061.26	26.96	89.26
9903.26	24.31	88.51	9983.26	25.36	88.06	10063.26	27.04	89.11
9905.26	24.32	88.54	9985.26	25.31	88.36	10065.26	27.06	89.34

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
10067.26	27.22	88.90	10147.26	30.50	89.24	10227.26	33.95	88.55
10069.26	27.28	89.07	10149.26	30.80	88.63	10229.26	34.00	88.54
10071.26	27.38	89.06	10151.26	30.88	88.65	10231.26	34.17	88.53
10073.26	27.34	89.28	10153.26	30.94	88.60	10233.26	34.27	88.30
10075.26	27.32	89.56	10155.26	31.02	88.63	10235.26	34.57	87.64
10077.26	27.46	89.52	10157.26	31.03	88.85	10237.26	34.58	87.96
10079.26	27.63	89.06	10159.26	31.18	88.57	10239.26	34.57	88.32
10081.26	27.71	89.25	10161.26	31.21	88.63	10241.26	34.76	88.00
10083.26	27.84	89.00	10163.26	31.28	88.68	10243.26	34.63	88.48
10085.26	27.87	89.07	10165.26	31.37	88.84	10245.26	34.71	88.64
10087.26	28.03	88.97	10167.26	31.45	88.86	10247.26	34.83	88.47
10089.26	28.09	88.97	10169.26	31.33	89.20	10249.26	34.71	88.89
10091.26	28.09	89.24	10171.26	31.59	88.78	10251.26	34.99	88.21
10093.26	28.28	89.20	10173.26	31.72	88.68	10253.26	35.11	88.22
10095.26	28.26	89.29	10175.26	31.70	88.87	10255.26	35.09	88.66
10097.26	28.42	89.14	10177.26	31.77	88.81	10257.26	35.10	88.62
10099.26	28.53	88.92	10179.26	31.98	88.57	10259.26	35.35	88.34
10101.26	28.43	89.45	10181.26	31.97	88.70	10261.26	35.42	88.24
10103.26	28.74	89.09	10183.26	32.01	88.77	10263.26	35.33	88.63
10105.26	28.87	88.87	10185.26	32.20	88.61	10265.26	35.31	88.72
10107.26	28.82	89.20	10187.26	32.25	88.59	10267.26	35.03	89.62
10109.26	28.94	89.11	10189.26	32.28	88.68	10269.26	35.28	88.88
10111.26	29.05	89.03	10191.26	32.42	88.59	10271.26	35.40	88.53
10113.26	29.08	89.29	10193.26	32.56	88.43	10273.26	35.60	88.19
10115.26	29.06	89.53	10195.26	32.68	88.37	10275.26	35.67	88.06
10117.26	29.27	89.18	10197.26	32.93	87.82	10277.26	35.43	88.83
10119.26	29.57	88.63	10199.26	32.97	87.85	10279.26	35.75	88.02
10121.26	29.51	89.17	10201.26	32.81	88.38	10281.26	35.63	88.41
10123.26	29.53	89.19	10203.26	32.70	88.93	10283.26	35.76	88.33
10125.26	29.59	89.23	10205.26	32.72	89.41	10285.26	35.64	88.64
10127.26	29.79	88.91	10207.26	33.09	88.43	10287.26	35.66	88.76
10129.26	29.77	89.11	10209.26	33.25	88.24	10289.26	35.73	88.72
10131.26	29.86	89.17	10211.26	33.24	88.49	10291.26	35.69	88.93
10133.26	30.07	88.71	10213.26	33.28	88.63	10293.26	35.71	88.92
10135.26	30.13	88.98	10215.26	33.41	88.44	10295.26	35.66	89.62
10137.26	30.18	88.99	10217.26	33.51	88.36	10297.26	35.84	89.33
10139.26	30.22	89.18	10219.26	33.59	88.50	10299.26	35.99	89.12
10141.26	30.44	88.77	10221.26	33.75	88.43	10301.26	35.78	89.41
10143.26	30.62	88.54	10223.26	33.84	88.19	10303.26	36.01	89.32
10145.26	30.50	88.99	10225.26	34.01	88.07	10305.26	36.15	89.29

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
10307.26	35.99	89.56	10387.26	34.56	92.42	10467.26	34.00	91.65
10309.26	36.01	90.22	10389.26	34.77	91.70	10469.26	33.92	91.88
10311.26	35.94	89.73	10391.26	34.85	91.57	10471.26	33.79	92.16
10313.26	35.93	89.66	10393.26	34.71	91.75	10473.26	33.84	92.11
10315.26	35.75	90.08	10395.26	34.79	91.63	10475.26	33.85	92.05
10317.26	35.80	90.09	10397.26	34.76	91.68	10477.26	33.76	92.31
10319.26	35.67	90.33	10399.26	34.65	91.86	10479.26	33.77	92.16
10321.26	35.82	90.08	10401.26	34.58	92.03	10481.26	33.86	91.88
10323.26	35.52	90.77	10403.26	34.52	92.06	10483.26	34.27	91.10
10325.26	35.71	90.40	10405.26	34.63	91.71	10485.26	34.04	91.51
10327.26	35.68	90.63	10407.26	34.50	91.87	10487.26	33.89	91.98
10329.26	35.61	90.76	10409.26	34.90	90.87	10489.26	34.03	91.73
10331.26	35.75	90.57	10411.26	34.61	91.49	10491.26	33.94	91.92
10333.26	35.84	90.34	10413.26	34.44	91.85	10493.26	34.04	91.81
10335.26	35.66	90.73	10415.26	34.30	92.01	10495.26	34.08	91.69
10337.26	35.41	91.33	10417.26	34.39	91.75	10497.26	34.11	91.96
10339.26	35.50	91.03	10419.26	34.48	91.44	10499.26	34.07	92.15
10341.26	35.45	91.17	10421.26	34.20	91.95	10501.26	34.20	92.13
10343.26	35.42	91.11	10423.26	34.25	91.80	10503.26	34.36	91.75
10345.26	35.30	91.40	10425.26	34.24	91.63	10505.26	34.24	91.98
10347.26	35.18	91.52	10427.26	34.19	91.71	10507.26	34.29	91.84
10349.26	35.30	91.19	10429.26	34.27	91.48	10509.26	33.98	92.63
10351.26	35.40	90.96	10431.26	33.97	92.18	10511.26	34.19	92.13
10353.26	35.09	91.71	10433.26	34.23	91.55	10513.26	34.44	91.62
10355.26	35.11	91.50	10435.26	34.17	91.66	10515.26	34.21	92.12
10357.26	35.20	91.22	10437.26	33.96	92.11	10517.26	34.27	92.13
10359.26	34.31	93.10	10439.26	33.83	92.34	10519.26	33.97	92.74
10361.26	34.74	92.28	10441.26	33.97	91.93	10521.26	34.17	92.21
10363.26	34.02	93.89	10443.26	34.05	91.56	10523.26	34.27	92.22
10365.26	35.20	90.56	10445.26	34.12	91.53	10525.26	34.17	92.43
10367.26	34.83	91.98	10447.26	34.02	91.60	10527.26	34.27	92.37
10369.26	34.96	91.66	10449.26	33.97	91.73	10529.26	34.30	92.23
10371.26	34.79	92.13	10451.26	33.86	92.02	10531.26	34.52	91.98
10373.26	34.70	92.35	10453.26	34.12	91.34	10533.26	34.55	92.08
10375.26	34.85	91.91	10455.26	34.06	91.51	10535.26	34.55	92.22
10377.26	34.93	91.70	10457.26	33.90	91.92	10537.26	34.54	92.35
10379.26	34.95	91.72	10459.26	33.87	92.08	10539.26	34.59	92.55
10381.26	34.74	92.07	10461.26	33.88	92.01	10541.26	34.57	92.60
10383.26	34.42	92.74	10463.26	34.01	91.66	10543.26	34.78	92.17
10385.26	34.59	92.40	10465.26	33.95	91.85	10545.26	35.04	91.85

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
10547.26	35.24	91.56	10627.51	36.88	92.96	10707.51	38.55	92.48
10549.26	35.05	92.07	10629.51	37.03	92.85	10709.51	38.57	92.38
10551.26	34.89	92.62	10631.51	37.15	92.56	10711.51	38.59	92.32
10553.26	35.04	92.40	10633.51	37.07	92.78	10713.51	38.64	92.14
10555.26	35.03	92.83	10635.51	37.16	92.82	10715.51	38.50	92.22
10557.26	35.37	92.03	10637.51	37.16	92.84	10717.51	38.40	92.40
10559.26	35.55	91.82	10639.51	37.26	92.70	10719.51	38.31	92.38
10561.26	35.42	92.41	10641.51	37.28	92.80	10721.51	38.07	92.91
10563.26	35.43	92.51	10643.51	37.47	92.53	10723.51	38.18	92.41
10565.26	35.62	92.55	10645.51	37.51	92.53	10725.51	37.92	92.81
10567.26	35.48	92.80	10647.51	37.67	92.42	10727.51	38.17	92.22
10569.26	35.62	92.39	10649.51	37.68	92.55	10729.51	38.16	92.23
10571.26	35.64	92.67	10651.51	37.60	92.85	10731.51	37.78	93.05
10573.51	35.93	92.22	10653.51	37.61	92.90	10733.51	37.82	92.80
10575.51	35.82	92.80	10655.51	37.89	92.41	10735.51	37.96	92.38
10577.51	35.80	92.86	10657.51	37.78	93.03	10737.51	37.90	92.58
10579.51	35.99	92.57	10659.51	37.97	92.39	10739.51	37.71	92.88
10581.51	36.21	92.20	10661.51	38.06	92.28	10741.51	37.63	93.08
10583.51	36.24	92.23	10663.51	38.03	92.41	10743.51	37.79	92.64
10585.51	36.23	92.71	10665.51	38.11	92.20	10745.51	37.89	92.35
10587.51	36.25	92.64	10667.51	38.32	91.91	10747.51	37.85	92.32
10589.51	36.26	92.56	10669.51	38.27	92.26	10749.51	37.61	92.94
10591.51	36.43	92.25	10671.51	38.26	92.41	10751.51	37.62	92.87
10593.51	36.12	93.24	10673.51	38.41	92.26	10753.51	37.72	92.57
10595.51	36.44	92.57	10675.51	38.26	92.70	10755.51	37.66	92.65
10597.51	36.42	92.69	10677.51	38.33	92.66	10757.51	37.62	92.74
10599.51	36.49	92.52	10679.51	38.49	92.47	10759.51	37.45	93.12
10601.51	36.52	92.62	10681.51	38.58	92.34	10761.51	37.61	92.80
10603.51	36.40	92.94	10683.51	38.57	92.57	10763.51	37.47	92.84
10605.51	36.48	92.87	10685.51	38.69	92.25	10765.51	37.39	92.97
10607.51	36.53	92.78	10687.51	38.45	93.06	10767.51	37.29	93.19
10609.51	36.84	92.02	10689.51	38.75	92.11	10769.51	37.40	93.07
10611.51	36.82	92.54	10691.51	38.64	92.38	10771.51	37.49	92.86
10613.51	36.70	92.75	10693.51	38.77	92.11	10773.51	37.44	92.93
10615.51	36.77	92.66	10695.51	38.76	92.19	10775.51	37.29	93.33
10617.51	36.67	92.86	10697.51	38.65	92.40	10777.51	37.40	93.10
10619.51	36.77	92.71	10699.51	38.80	91.93	10779.51	37.27	93.67
10621.51	36.88	92.63	10701.51	38.78	92.19	10781.51	37.34	93.42
10623.51	36.84	92.76	10703.51	38.77	92.13	10783.51	37.17	93.84
10625.51	36.91	92.81	10705.51	38.58	92.53	10785.51	37.40	93.30

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
10787.51	37.53	93.30	10865.76	35.69	95.27	10945.76	35.83	95.89
10789.51	37.76	93.21	10867.76	35.70	95.34	10947.76	35.80	95.98
10791.51	37.78	93.07	10869.76	35.54	95.83	10949.76	35.70	96.33
10793.51	37.61	93.28	10871.76	35.46	95.96	10951.76	35.73	96.17
10795.51	37.67	93.22	10873.76	35.55	95.72	10953.76	35.49	96.95
10797.51	37.81	92.91	10875.76	35.45	95.90	10955.76	35.69	96.46
10799.76	37.90	93.09	10877.76	35.36	96.13	10957.76	35.61	96.63
10801.76	37.76	93.50	10879.76	35.56	95.71	10959.76	35.70	96.48
10803.76	37.55	93.99	10881.76	35.64	95.46	10961.76	35.62	96.72
10805.76	37.68	93.52	10883.76	35.58	95.69	10963.76	35.58	96.84
10807.76	37.69	93.61	10885.76	35.66	95.52	10965.76	35.55	96.80
10809.76	37.68	93.65	10887.76	35.60	95.63	10967.76	35.58	96.92
10811.76	37.56	93.88	10889.76	35.46	95.63	10969.76	35.79	96.48
10813.76	37.61	93.59	10891.76	35.47	95.64	10971.76	35.91	96.14
10815.76	37.39	93.89	10893.76	35.51	95.72	10973.76	35.89	96.32
10817.76	37.22	94.10	10895.76	35.40	96.11	10975.76	35.65	96.90
10819.76	37.18	94.05	10897.76	35.71	95.43	10977.76	35.64	96.87
10821.76	37.16	94.08	10899.76	35.43	96.12	10979.76	35.90	96.35
10823.76	37.06	94.28	10901.76	35.58	95.68	10981.76	35.98	96.22
10825.76	37.58	93.03	10903.76	35.80	95.28	10983.76	35.70	97.05
10827.76	37.29	93.46	10905.76	35.60	95.69	10985.76	35.80	96.82
10829.76	36.82	94.58	10907.76	35.70	95.51	10987.76	35.77	96.86
10831.76	36.70	94.71	10909.76	35.55	96.11	10989.76	35.83	96.77
10833.76	36.71	94.62	10911.76	35.69	95.64	10991.76	36.03	95.93
10835.76	36.68	94.66	10913.76	35.65	95.81	10993.76	35.77	97.11
10837.76	36.63	94.73	10915.76	35.58	95.98	10995.76	35.95	96.66
10839.76	36.32	95.30	10917.76	35.83	95.38	10997.76	35.68	97.49
10841.76	36.61	94.58	10919.76	35.75	95.48	10999.76	35.74	97.27
10843.76	36.35	95.23	10921.76	35.61	95.82	11001.76	35.79	97.38
10845.76	36.18	95.41	10923.76	35.71	95.72	11003.76	35.78	97.33
10847.76	36.01	95.55	10925.76	35.60	96.14	11005.76	35.90	96.97
10849.76	36.12	95.19	10927.76	35.46	96.27	11007.76	35.74	97.39
10851.76	35.82	95.83	10929.76	35.70	95.88	11009.76	35.89	95.26
10853.76	36.03	95.30	10931.76	35.83	95.56	11011.76	35.90	95.21
10855.76	36.14	94.79	10933.76	35.75	95.85	11013.76	35.59	95.81
10857.76	35.96	95.01	10935.76	35.80	95.70	11015.76	35.77	95.47
10859.76	35.79	95.35	10937.76	35.73	96.08	11017.76	35.92	94.98
10861.76	35.89	94.87	10939.76	35.67	96.26	11019.76	36.18	94.33
10863.76	35.63	95.42	10941.76	35.69	96.22	11021.76	35.74	95.62
10863.76	35.63	95.42	10943.76	35.69	96.31	11023.76	35.56	96.11

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
11025.76	35.57	96.23	11105.76	37.12	92.80	11185.76	35.01	96.03
11027.76	35.69	95.92	11107.76	36.10	95.73	11187.76	35.10	95.80
11029.76	35.80	95.99	11109.76	35.96	96.10	11189.76	34.96	96.33
11031.76	35.92	95.62	11111.76	36.10	95.56	11191.76	35.03	95.58
11033.76	35.96	95.28	11113.76	36.06	95.56	11193.76	35.04	95.53
11035.76	35.93	95.57	11115.76	35.71	96.32	11195.76	35.40	94.54
11037.76	35.87	95.85	11117.76	35.66	96.35	11197.76	35.54	94.21
11039.76	35.75	96.21	11119.76	35.92	95.71	11199.76	34.77	96.20
11041.76	36.04	95.37	11121.76	35.53	96.03	11201.76	34.80	95.89
11043.76	36.75	93.86	11123.76	35.66	95.99	11203.76	34.96	95.55
11045.76	35.96	95.82	11125.76	35.48	96.31	11205.76	35.20	94.71
11047.76	35.83	96.14	11127.76	35.32	97.03	11207.76	34.92	95.42
11049.76	36.09	95.47	11129.76	35.92	95.41	11209.76	35.12	95.09
11051.76	35.92	96.10	11131.76	35.27	97.01	11211.76	34.96	95.24
11053.76	36.04	95.62	11133.76	36.07	94.84	11213.76	34.71	95.63
11055.76	35.93	96.29	11135.76	35.48	96.34	11215.76	34.73	95.78
11057.76	35.80	96.69	11137.76	34.78	98.17	11217.76	34.79	95.50
11059.76	36.25	95.27	11139.76	36.57	93.75	11219.76	35.46	93.82
11061.76	36.12	95.80	11141.76	35.98	95.09	11221.76	34.39	96.37
11063.76	35.93	96.44	11143.76	35.59	96.02	11223.76	34.69	95.69
11065.76	36.21	95.48	11145.76	35.50	96.07	11225.76	35.11	94.40
11067.76	36.19	95.73	11147.76	35.90	95.17	11227.76	34.66	95.28
11069.76	36.18	95.98	11149.76	35.96	94.91	11229.76	34.64	95.34
11071.76	36.27	96.00	11151.76	35.25	96.64	11231.76	34.97	94.52
11073.76	36.19	96.10	11153.76	35.53	95.90	11233.76	34.70	95.10
11075.76	36.10	96.38	11155.76	35.71	94.92	11235.76	34.54	95.35
11077.76	36.28	95.87	11157.76	35.32	96.15	11237.76	34.56	95.21
11079.76	36.44	95.41	11159.76	34.81	97.46	11239.76	34.58	94.77
11081.76	35.65	97.65	11161.76	35.49	95.63	11241.76	34.56	95.03
11083.76	35.40	97.79	11163.76	35.86	94.66	11243.76	34.65	94.53
11085.76	36.58	95.14	11165.76	34.79	97.29	11245.76	34.26	95.19
11087.76	36.40	95.60	11167.76	35.34	95.79	11247.76	34.37	94.77
11089.76	35.90	96.84	11169.76	35.46	95.59	11249.76	34.26	95.00
11091.76	36.05	96.41	11171.76	35.21	95.89	11251.76	34.36	94.69
11093.76	35.93	96.65	11173.76	35.45	95.48	11253.76	34.15	94.96
11095.76	36.49	95.38	11175.76	35.35	95.67	11255.76	34.15	94.86
11097.76	36.37	95.45	11177.76	35.24	95.85	11257.76	34.24	94.50
11099.76	36.22	96.21	11179.76	35.24	95.69	11259.76	34.10	94.69
11101.76	36.36	95.79	11181.76	35.23	95.74	11261.76	33.98	94.79
11103.76	35.95	96.11	11183.76	35.19	95.68	11263.76	34.03	95.03

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
11265.76	34.03	94.68	11346.01	31.51	94.99	11426.01	29.39	96.96
11267.76	33.79	95.20	11348.01	31.32	95.41	11428.01	29.41	96.60
11269.76	33.49	95.89	11350.01	31.45	94.82	11430.01	29.41	96.52
11271.76	33.98	94.98	11352.01	31.38	94.80	11432.01	28.99	97.36
11273.76	33.93	94.81	11354.01	31.35	95.83	11434.01	29.19	96.34
11275.76	33.97	94.62	11356.01	31.44	95.02	11436.01	29.08	96.78
11277.76	34.07	94.31	11358.01	31.04	95.77	11438.01	29.00	97.10
11279.76	34.01	94.27	11360.01	31.09	95.57	11440.01	28.98	96.83
11281.76	33.87	94.68	11362.01	30.90	95.67	11442.01	29.15	96.56
11283.76	33.77	94.70	11364.01	30.99	95.43	11444.01	29.06	97.00
11285.76	33.54	95.09	11366.01	30.81	95.71	11446.01	29.03	96.56
11287.76	33.77	94.15	11368.01	30.73	95.64	11448.01	28.86	97.01
11289.76	33.49	94.70	11370.01	30.65	95.93	11450.01	28.99	96.91
11291.76	33.53	94.39	11372.01	30.69	95.59	11452.01	28.97	96.44
11293.76	33.37	94.67	11374.01	30.41	96.25	11454.01	28.93	96.75
11295.76	33.16	94.84	11376.01	30.44	96.24	11456.01	28.94	96.59
11297.76	33.09	94.84	11378.01	30.37	96.14	11458.01	28.87	96.62
11299.76	33.01	94.93	11380.01	30.55	95.76	11460.01	28.77	96.70
11301.76	33.24	94.23	11382.01	30.40	96.23	11462.01	28.73	96.69
11303.76	33.24	93.85	11384.01	30.29	96.35	11464.01	28.80	96.43
11305.76	32.82	94.91	11386.01	30.52	95.52	11466.01	28.69	96.61
11307.76	33.01	93.97	11388.01	30.23	96.40	11468.01	28.32	97.23
11309.76	32.93	94.17	11390.01	30.25	96.44	11470.01	28.55	96.75
11311.76	32.94	94.16	11392.01	30.09	96.52	11472.01	28.59	96.56
11313.76	32.74	94.27	11394.01	30.07	96.38	11474.01	28.54	96.80
11315.76	32.68	94.60	11396.01	30.19	96.01	11476.01	28.50	96.48
11317.76	32.58	94.52	11398.01	30.14	96.08	11478.01	28.47	96.69
11319.76	32.47	94.66	11400.01	29.86	96.71	11480.01	28.46	96.82
11321.76	32.44	94.66	11402.01	29.87	96.44	11482.01	28.50	96.45
11323.76	32.50	94.55	11404.01	29.83	96.39	11484.01	28.59	96.47
11326.01	32.18	94.78	11406.01	29.84	96.41	11486.01	28.28	97.13
11328.01	32.34	94.50	11408.01	29.83	96.45	11488.01	28.42	96.73
11330.01	32.43	93.77	11410.01	29.63	96.82	11490.01	28.50	96.50
11332.01	31.87	95.08	11412.01	29.65	96.76	11492.01	28.21	97.04
11334.01	31.38	96.02	11414.01	29.63	96.51	11494.01	28.40	96.57
11336.01	31.56	95.44	11416.01	29.55	96.69	11496.01	28.31	96.38
11338.01	32.47	92.88	11418.01	29.47	96.60	11498.01	28.26	96.62
11340.01	31.97	93.78	11420.01	29.49	96.81	11500.01	28.27	96.46
11342.01	31.67	94.56	11422.01	29.47	96.63	11502.01	28.36	96.16
11344.01	31.34	95.49	11424.01	29.25	97.04	11504.01	28.15	96.48

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
11506.01	28.02	96.64	11586.01	26.40	96.27	11666.01	26.42	96.79
11508.01	28.24	96.17	11588.01	26.23	96.60	11668.01	26.35	97.05
11510.01	28.08	96.71	11590.01	26.45	96.25	11670.01	26.41	96.81
11512.01	27.98	96.62	11592.01	26.28	96.65	11672.01	26.40	97.11
11514.01	27.77	97.21	11594.01	26.23	96.89	11674.01	26.42	96.96
11516.01	27.72	96.99	11596.01	26.30	96.84	11676.01	26.36	96.95
11518.01	27.65	96.89	11598.01	26.40	96.40	11678.01	26.64	96.66
11520.01	27.90	96.31	11600.01	26.32	96.70	11680.01	26.51	96.95
11522.01	27.62	96.68	11602.01	26.26	96.84	11682.01	26.61	96.59
11524.01	27.74	96.34	11604.01	26.24	96.68	11684.01	26.56	96.96
11526.01	27.79	96.02	11606.01	26.34	96.47	11686.01	26.62	96.91
11528.01	27.65	96.30	11608.01	26.44	96.30	11688.01	26.66	96.84
11530.01	27.48	96.78	11610.01	26.29	96.64	11690.01	26.45	97.20
11532.01	27.54	96.06	11612.01	26.25	96.88	11692.01	26.51	97.27
11534.01	27.40	96.25	11614.01	26.29	96.66	11694.01	26.45	97.42
11536.01	27.26	96.39	11616.01	26.31	96.75	11696.01	27.64	95.14
11538.01	27.40	95.98	11618.01	26.19	96.95	11698.01	26.69	97.05
11540.01	27.32	95.98	11620.01	26.19	97.09	11700.01	26.93	96.49
11542.01	27.19	95.83	11622.01	26.27	96.85	11702.01	26.77	96.72
11544.01	27.14	96.81	11624.01	26.16	97.18	11704.01	26.82	96.89
11546.01	26.81	99.54	11626.01	26.34	96.66	11706.01	26.75	97.13
11548.01	26.90	96.47	11628.01	26.33	96.94	11708.01	26.66	97.18
11550.01	27.00	96.42	11630.01	26.34	96.86	11710.01	26.70	97.20
11552.01	26.94	96.66	11632.01	25.87	97.94	11712.01	26.53	97.67
11554.01	27.03	95.88	11634.01	26.38	96.50	11714.01	26.80	96.89
11556.01	27.05	95.89	11636.01	26.36	96.65	11716.01	26.92	96.71
11558.01	26.81	96.76	11638.01	26.35	96.80	11718.01	26.79	96.76
11560.01	27.04	95.79	11640.01	26.38	96.65	11720.01	26.79	96.92
11562.01	26.76	96.12	11642.01	26.40	96.60	11722.01	26.76	97.13
11564.01	26.71	96.52	11644.01	26.31	96.99	11724.01	26.80	96.93
11566.01	26.79	95.79	11646.01	26.30	96.89	11726.01	26.96	96.62
11568.01	26.70	96.18	11648.01	26.46	96.51	11728.01	27.08	96.61
11570.01	26.60	96.09	11650.01	26.35	96.60	11730.01	27.02	96.60
11572.01	26.44	96.56	11652.01	26.34	96.62	11732.01	27.00	96.79
11574.01	26.46	96.63	11654.01	26.37	96.76	11734.01	27.07	96.75
11576.01	26.37	96.78	11656.01	26.35	96.78	11736.01	27.22	96.19
11578.01	26.34	96.43	11658.01	26.24	97.21	11738.01	26.89	97.06
11580.01	26.29	96.47	11660.01	26.19	97.11	11740.01	27.15	96.44
11582.01	26.34	96.43	11662.01	26.57	96.03	11742.01	27.06	96.84
11584.01	26.35	96.12	11664.01	26.45	96.81	11744.01	27.11	97.17

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
11746.01	27.24	96.57	11826.01	28.62	96.03	11906.01	30.06	95.71
11748.01	27.17	96.84	11828.01	28.57	96.30	11908.01	29.98	95.91
11750.01	27.30	96.63	11830.01	28.41	96.46	11910.01	29.97	96.02
11752.01	27.31	96.43	11832.01	28.65	96.14	11912.01	30.23	95.59
11754.01	27.41	96.27	11834.01	28.88	95.50	11914.01	29.98	95.92
11756.01	27.52	96.24	11836.01	28.52	96.62	11916.01	30.17	95.31
11758.01	27.45	96.60	11838.01	28.77	95.94	11918.01	30.12	95.82
11760.01	27.41	96.59	11840.01	28.68	96.44	11920.01	30.35	95.03
11762.01	27.58	96.24	11842.01	28.68	96.57	11922.01	30.33	94.93
11764.01	27.44	96.48	11844.01	28.80	95.89	11924.01	30.18	95.30
11766.01	27.67	96.14	11846.01	28.76	96.37	11926.01	30.22	95.33
11768.01	27.66	96.49	11848.01	28.85	96.20	11928.01	30.33	94.89
11770.01	27.49	96.63	11850.01	28.93	96.21	11930.01	30.38	95.03
11772.01	27.69	96.40	11852.01	28.84	96.37	11932.01	30.51	94.59
11774.01	27.64	96.67	11854.01	28.85	96.59	11934.01	30.51	94.29
11776.01	27.58	97.05	11856.01	28.99	96.20	11936.01	30.47	94.61
11778.01	27.67	96.58	11858.01	29.06	96.23	11938.01	30.46	94.81
11780.01	27.87	95.93	11860.01	28.96	96.21	11940.01	30.42	94.64
11782.01	27.67	96.72	11862.01	29.13	96.12	11942.01	30.47	94.78
11784.01	27.71	96.91	11864.01	29.07	96.37	11944.01	30.30	95.41
11786.01	27.96	96.30	11866.01	29.34	95.70	11946.01	30.48	94.72
11788.01	27.95	96.51	11868.01	29.74	95.00	11948.01	30.65	94.41
11790.01	27.98	96.27	11870.01	28.84	97.31	11950.01	30.60	94.64
11792.01	28.15	96.09	11872.01	29.37	96.14	11952.01	30.49	94.94
11794.01	28.14	96.34	11874.01	29.51	96.01	11954.01	30.08	95.93
11796.01	28.07	96.37	11876.01	29.46	96.03	11956.01	31.02	93.58
11798.01	28.26	96.11	11878.01	29.53	96.17	11958.01	30.62	94.98
11800.01	28.22	96.14	11880.01	29.65	95.91	11960.01	30.74	94.26
11802.01	28.16	96.38	11882.01	29.62	96.04	11962.01	30.60	94.85
11804.01	28.22	96.57	11884.01	29.71	95.99	11964.01	30.56	95.23
11806.01	28.29	96.25	11886.01	29.68	96.03	11966.01	30.63	95.16
11808.01	28.07	96.47	11888.01	29.69	96.21	11968.01	30.85	94.23
11810.01	28.46	95.73	11890.01	29.85	95.83	11970.01	30.70	94.97
11812.01	28.23	96.68	11892.01	29.73	96.05	11972.01	30.87	94.65
11814.01	28.38	96.06	11894.01	29.79	96.02	11974.01	30.81	94.85
11816.01	28.46	95.86	11896.01	29.87	95.96	11976.01	30.71	95.29
11818.01	28.48	96.11	11898.01	29.94	96.11	11978.01	30.72	95.15
11820.01	28.47	96.20	11900.01	30.02	95.83	11980.01	30.98	94.43
11822.01	28.46	96.20	11902.01	30.14	95.58	11982.01	30.93	94.95
11824.01	28.59	95.89	11904.01	29.94	96.18	11984.01	30.90	95.04

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
11986.01	30.75	95.48	12066.01	31.93	94.66	12146.01	32.76	95.54
11988.01	30.75	95.61	12068.01	31.95	94.65	12148.01	32.65	95.83
11990.01	30.95	95.34	12070.01	32.12	94.30	12150.01	32.86	95.43
11992.01	31.04	95.01	12072.01	32.32	93.84	12152.01	32.82	95.64
11994.01	30.81	95.69	12074.01	31.90	94.73	12154.01	32.89	95.41
11996.01	30.24	97.37	12076.01	31.99	95.09	12156.01	32.86	95.65
11998.01	31.38	94.41	12078.01	31.96	95.10	12158.01	32.81	95.76
12000.01	31.09	95.27	12080.01	31.94	95.09	12160.01	32.77	95.94
12002.01	31.17	95.18	12082.01	32.20	94.54	12162.01	33.04	95.42
12004.01	31.13	95.08	12084.01	32.37	94.00	12164.01	32.83	96.20
12006.01	31.19	95.41	12086.01	32.12	94.77	12166.01	32.79	96.28
12008.01	30.94	95.96	12088.01	32.16	94.82	12168.01	32.90	96.04
12010.01	30.95	96.06	12090.01	32.09	95.15	12170.01	32.95	95.99
12012.01	31.28	95.40	12092.01	32.21	94.84	12172.01	32.88	96.23
12014.01	30.78	96.04	12094.01	32.00	95.46	12174.01	33.06	95.87
12016.01	31.48	94.52	12096.01	32.27	94.87	12176.01	33.12	96.00
12018.01	31.20	95.26	12098.01	32.37	94.62	12178.01	32.93	96.53
12020.01	31.75	93.96	12100.01	32.40	94.50	12180.01	33.18	96.09
12022.01	31.21	95.28	12102.01	32.10	95.27	12182.01	33.16	96.39
12024.01	31.50	95.00	12104.01	32.29	94.95	12184.01	33.14	96.51
12026.01	31.22	95.37	12106.01	32.31	95.14	12186.01	33.22	96.71
12028.01	31.05	95.84	12108.01	32.47	94.68	12188.01	33.35	96.39
12030.01	31.27	95.25	12110.01	32.42	94.97	12190.01	33.33	96.63
12032.01	30.63	96.70	12112.01	32.56	94.62	12192.01	33.60	96.15
12034.01	31.99	93.38	12114.01	32.49	94.75	12194.01	33.39	96.87
12036.01	31.39	95.20	12116.01	32.50	94.96	12196.01	33.45	97.03
12038.01	31.42	95.13	12118.01	32.41	95.29	12198.01	33.53	97.01
12040.01	31.57	94.80	12120.01	32.24	95.83	12200.01	33.63	97.09
12042.01	31.55	95.02	12122.01	32.60	94.93	12202.01	33.70	97.08
12044.01	31.35	95.37	12124.01	32.44	95.31	12204.01	33.65	97.44
12046.01	31.53	95.31	12126.01	32.78	94.52	12206.01	33.90	96.82
12048.01	31.51	95.12	12128.01	32.57	95.17	12208.01	33.89	97.13
12050.01	31.69	94.69	12130.01	32.65	95.15	12210.01	33.89	97.43
12052.01	31.58	95.32	12132.01	32.73	94.86	12212.01	33.91	97.68
12054.01	31.81	94.62	12134.01	32.54	95.41	12214.01	33.98	97.57
12056.01	31.79	94.45	12136.01	32.60	95.32	12216.01	34.07	97.66
12058.01	31.71	95.09	12138.01	32.60	95.57	12218.01	34.00	98.03
12060.01	31.71	94.95	12140.01	32.64	95.45	12220.01	34.18	97.73
12062.01	31.79	95.05	12142.01	32.67	95.52	12222.01	34.29	97.77
12064.01	31.96	94.40	12144.01	32.59	95.70	12224.01	34.30	97.74

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
12226.01	34.45	97.66	12306.26	34.93	98.69	12386.26	34.63	99.09
12228.01	34.21	98.39	12308.26	35.01	98.51	12388.26	34.64	99.07
12230.01	34.51	97.87	12310.26	35.02	98.53	12390.26	34.65	98.97
12232.01	34.59	97.68	12312.26	35.06	98.37	12392.26	34.60	99.19
12234.01	34.56	97.94	12314.26	34.98	98.56	12394.26	34.59	99.18
12236.01	34.53	98.12	12316.26	35.00	98.56	12396.26	34.49	99.52
12238.01	34.66	97.87	12318.26	35.07	98.31	12398.26	34.64	99.21
12240.01	34.54	98.20	12320.26	34.91	98.79	12400.26	34.42	99.70
12242.26	34.61	98.00	12322.26	34.96	98.74	12402.26	34.65	99.23
12244.26	34.60	98.23	12324.26	34.96	98.73	12404.26	34.75	99.06
12246.26	34.78	97.70	12326.26	34.92	98.82	12406.26	34.67	99.35
12248.26	34.72	97.85	12328.26	34.99	98.67	12408.26	34.74	99.14
12250.26	34.93	97.37	12330.26	34.98	98.65	12410.26	34.70	99.24
12252.26	34.56	98.32	12332.26	34.98	98.60	12412.26	34.67	99.28
12254.26	34.76	97.83	12334.26	34.96	98.60	12414.26	34.69	99.34
12256.26	34.72	97.90	12336.26	34.94	98.69	12416.26	34.53	99.68
12258.26	34.83	97.73	12338.26	34.88	98.82	12418.26	34.59	99.65
12260.26	34.69	98.14	12340.26	35.02	98.41	12420.26	34.52	99.68
12262.26	34.52	98.73	12342.26	34.99	98.53	12422.26	34.67	99.45
12264.26	34.76	98.09	12344.26	34.93	98.65	12424.26	34.62	99.51
12266.26	34.85	97.99	12346.26	34.81	98.93	12426.26	34.74	99.33
12268.26	34.79	98.24	12348.26	34.90	98.75	12428.26	34.73	99.36
12270.26	34.69	98.49	12350.26	34.77	98.95	12430.26	34.76	99.46
12272.26	34.67	98.73	12352.26	34.78	99.05	12432.26	34.66	99.66
12274.26	34.93	98.13	12354.26	34.87	98.75	12434.26	34.52	100.17
12276.26	34.95	98.13	12356.26	34.85	98.88	12436.26	34.81	99.50
12278.26	34.93	98.18	12358.26	34.87	98.81	12438.26	34.82	99.49
12280.26	34.88	98.35	12360.26	34.76	99.06	12440.26	34.75	99.64
12282.26	34.95	98.28	12362.26	35.06	98.36	12442.26	34.79	99.37
12284.26	34.97	98.42	12364.26	34.87	99.00	12444.26	34.76	99.58
12286.26	34.93	98.49	12366.26	34.80	98.99	12446.26	34.71	99.76
12288.26	34.93	98.57	12368.26	34.87	98.88	12448.26	34.65	99.84
12290.26	34.96	98.54	12370.26	34.89	98.77	12450.26	34.74	99.73
12292.26	35.03	98.31	12372.26	34.82	98.94	12452.26	34.71	99.76
12294.26	34.75	99.13	12374.26	34.73	99.16	12454.26	34.79	99.53
12296.26	34.93	98.62	12376.26	34.74	99.11	12456.26	34.43	100.54
12298.26	35.01	98.52	12378.26	34.89	98.63	12458.26	34.76	99.52
12300.26	35.02	98.47	12380.26	34.63	99.26	12460.26	34.64	99.98
12302.26	35.05	98.39	12382.26	34.76	98.90	12462.26	35.08	98.92
12304.26	35.00	98.45	12384.26	34.72	98.76	12464.26	34.68	99.84

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
12466.26	35.38	98.67	12546.26	35.00	100.12	12626.26	36.17	101.31
12468.26	34.86	99.70	12548.26	34.71	100.94	12628.26	36.24	101.50
12470.26	34.97	99.60	12550.26	34.77	100.98	12630.26	36.25	101.73
12472.26	34.97	99.55	12552.26	34.96	100.46	12632.26	36.50	100.86
12474.26	34.80	99.83	12554.26	34.97	100.31	12634.26	36.31	101.82
12476.26	34.81	99.93	12556.26	34.91	100.45	12636.26	36.44	101.60
12478.26	34.88	99.84	12558.26	35.10	100.45	12638.26	36.33	101.86
12480.26	34.78	100.11	12560.26	35.21	100.22	12640.26	36.43	101.83
12482.26	34.89	99.88	12562.26	35.09	100.66	12642.26	36.60	101.29
12484.26	34.81	100.06	12564.26	34.95	100.99	12644.26	36.54	101.68
12486.26	34.84	100.06	12566.26	35.16	100.66	12646.26	36.63	101.74
12488.26	35.15	99.38	12568.26	35.15	100.90	12648.26	36.63	101.87
12490.26	34.88	100.03	12570.26	35.14	100.80	12650.26	36.68	101.63
12492.26	35.00	99.62	12572.26	35.24	100.73	12652.26	36.67	101.94
12494.26	34.84	99.88	12574.26	35.29	100.82	12654.26	36.78	101.85
12496.26	34.73	100.42	12576.26	35.15	101.12	12656.26	36.93	101.42
12498.26	35.12	99.40	12578.26	35.34	100.91	12658.26	36.87	101.59
12500.26	34.84	100.22	12580.26	35.32	100.91	12660.26	36.98	101.48
12502.26	34.88	99.90	12582.26	35.32	100.87	12662.26	36.98	101.79
12504.26	34.83	100.07	12584.26	35.38	100.98	12664.26	37.12	101.66
12506.26	34.87	100.07	12586.26	35.50	100.65	12666.26	37.17	101.42
12508.26	34.79	100.39	12588.26	35.38	101.11	12668.26	37.34	101.32
12510.26	34.83	100.17	12590.26	35.37	101.33	12670.26	37.33	101.41
12512.26	34.83	100.22	12592.26	35.37	101.40	12672.26	37.35	101.48
12514.26	34.90	100.23	12594.26	35.45	101.12	12674.26	37.28	101.66
12516.26	35.09	99.77	12596.26	35.49	101.13	12676.26	37.34	101.54
12518.26	34.90	100.14	12598.26	35.64	101.02	12678.26	37.27	101.85
12520.26	34.85	100.35	12600.26	35.59	101.23	12680.26	37.39	101.49
12522.26	34.84	100.33	12602.26	35.79	100.92	12682.26	37.34	101.77
12524.26	35.09	99.89	12604.26	35.68	101.16	12684.26	37.29	101.98
12526.26	35.10	99.95	12606.26	35.82	101.19	12686.26	37.34	101.92
12528.26	34.94	100.30	12608.26	35.81	101.32	12688.26	37.65	101.05
12530.26	34.87	100.43	12610.26	35.73	101.44	12690.26	37.45	101.73
12532.26	34.92	100.42	12612.26	35.90	101.25	12692.26	37.65	101.17
12534.26	34.94	100.43	12614.26	36.02	100.98	12694.26	37.53	101.48
12536.26	34.78	100.78	12616.26	35.92	101.39	12696.26	37.60	101.36
12538.26	34.97	100.16	12618.26	36.09	101.30	12698.26	37.68	101.20
12540.26	34.86	100.34	12620.26	36.09	101.43	12700.26	37.53	101.57
12542.26	35.09	99.84	12622.26	36.17	101.36	12702.26	37.64	101.33
12544.26	34.93	100.32	12624.26	36.14	101.42	12704.26	37.60	101.51

Table C-1

Original Data of the Well DRL
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)
12706.26	37.50	101.76	12734.26	37.86	101.18	12762.26	37.73	101.23
12708.26	37.59	101.40	12736.26	37.73	101.38	12764.26	37.65	101.41
12710.26	37.62	101.32	12738.26	37.80	101.21	12766.26	37.65	101.30
12712.26	37.58	101.41	12740.26	37.74	101.30	12768.26	37.68	101.26
12714.26	37.65	101.49	12742.26	37.69	101.37	12770.26	37.65	101.32
12716.26	37.72	101.30	12744.26	37.67	101.41	12772.26	37.66	101.30
12718.26	37.61	101.51	12746.26	37.64	101.44	12774.26	37.66	101.31
12720.26	37.67	101.38	12748.26	37.69	101.38	12776.26	37.66	101.31
12722.26	37.64	101.56	12750.26	37.75	101.19	12778.26	37.66	101.30
12724.26	37.73	101.37	12752.26	37.69	101.35	12780.26	37.66	101.30
12726.26	37.81	101.43	12754.26	37.64	101.44	12782.26	37.66	101.28
12728.26	37.80	101.46	12756.26	37.65	101.43	12784.26	37.65	101.31
12730.26	37.81	101.43	12758.26	37.81	101.05			
12732.26	37.75	101.53	12760.26	37.70	101.27			

Table C-2

Location of the Bottom of the Bore Hole for Sixty-four Reduced Data Sets of the Well DRL

No #	FL-Name (.dat)	Ns #	1/Ns 1/#	Portion	TVD (ft)	N+/S- (ft)	E+/W- (ft)
1	DRI	1958	0.000511	"1"	12250.07	165.03	2203.86
2	DRSM70	1933	0.000517	"69/70"	12250.04	165.10	2203.91
3	DRSM60	1928	0.000519	"59/60"	12250.08	164.99	2203.86
4	DRSM50	1921	0.000521	"49/50"	12250.07	165.05	2203.87
5	DRSM40	1912	0.000523	"39/40"	12250.03	165.12	2203.92
6	DRSM30	1895	0.000528	"29/30"	12250.06	165.03	2203.88
7	DRSM25	1882	0.000531	"24/25"	12250.05	165.08	2203.91
8	DRSM20	1863	0.000537	"19/20"	12250.04	165.06	2203.91
9	DRSM19	1857	0.000539	"18/19"	12250.09	164.95	2203.84
10	DRSM18	1852	0.000540	"17/18"	12250.03	165.05	2203.94
11	DRSM17	1845	0.000542	"16/17"	12250.07	165.01	2203.83
12	DRSM16	1838	0.000544	"15/16"	12250.07	164.97	2203.87
13	DRSM15	1830	0.000546	"14/15"	12250.03	165.13	2203.92
14	DRSM14	1821	0.000549	"13/14"	12250.06	165.06	2203.86
15	DRSM13	1810	0.000552	"12/13"	12250.06	165.11	2203.88
16	DRSM12	1797	0.000556	"11/12"	12250.1	164.93	2203.82
17	DRSM11	1783	0.000561	"10/11"	12250.04	165.15	2203.91
18	DRSM10	1765	0.000567	"9/10"	12250.03	165.11	2203.92
19	DRSM9	1743	0.000574	"8/9"	12250.02	165.05	2203.96
20	DRSM8	1716	0.000583	"7/8"	12250.13	164.85	2203.77
21	DRSM7	1681	0.000595	"6/7"	12250.08	164.99	2203.83
22	DRSM6	1634	0.000612	"5/6"	12250.43	164.97	2203.85
23	DRSM5	1569	0.000637	"4/5"	12250.03	165.17	2203.93
24	DRSM4	1471	0.000680	"3/4"	12250.06	165.00	2203.88
25	DRSM3	1308	0.000765	"2/3"	12250.1	164.90	2203.79
26	DR2	981	0.001019	"1/2"	12249.96	165.23	2204.05
27	DR3	655	0.001527	"1/3"	12250.19	164.34	2203.60
28	DR4	492	0.002033	"1/4"	12250.03	165.05	2203.93
29	DR5	394	0.002538	"1/5"	12249.92	165.47	2204.17
30	DR6	329	0.003040	"1/6"	12249.84	164.94	2204.17
31	DR7	282	0.003546	"1/7"	12250.45	163.82	2203.32
32	DR8	247	0.004049	"1/8"	12250.16	164.50	2203.69
33	DR9	220	0.004545	"1/9"	12250.35	163.66	2203.36
34	DR10	197	0.005076	"1/10"	12250.1	165.00	2203.89

Table C-2

Location of the Bottom of the Bore Hole for
Sixty-four Reduced Data Sets of the Well DRL
(continued)

No #	FL-Name (.dat)	Ns #	1/Ns 1/#	Portion	TVD (ft)	N+/S- (ft)	E+/W- (ft)
35	DR12	166	0.006024	"1/12"	12249.7	165.34	2204.47
36	DR14	142	0.007042	"1/14"	12250.57	163.76	2203.01
37	DR16	125	0.008000	"1/16"	12250.21	164.28	2203.59
38	DR18	111	0.009009	"1/18"	12250.06	163.85	2203.83
39	DR20	100	0.010000	"1/20"	12250.29	163.70	2203.52
40	DR22	91	0.010989	"1/22"	12250.11	165.57	2203.90
41	DR24	84	0.011905	"1/24"	12249.57	165.02	2204.91
42	DR26	78	0.012821	"1/26"	12249.55	165.02	2204.91
43	DR28	72	0.013889	"1/28"	12250.96	162.94	2202.50
44	DR30	68	0.014706	"1/30"	12250.05	164.01	2203.80
45	DR33	62	0.016129	"1/33"	12250.71	162.94	2202.68
46	DR36	57	0.017544	"1/36"	12249.76	165.75	2204.28
47	DR39	53	0.018868	"1/39"	12249.66	165.45	2204.68
48	DR42	49	0.020408	"1/42"	12250.97	162.93	2202.70
49	DR45	46	0.021739	"1/45"	12250.29	164.05	2203.96
50	DR48	43	0.023256	"1/48"	12249.06	164.90	2206.04
51	DR51	41	0.024390	"1/51"	12250.3	161.88	2203.59
52	DR54	39	0.025641	"1/54"	12250.65	161.96	2205.05
53	DR57	37	0.027027	"1/57"	12248.23	171.18	2207.25
54	DR60	35	0.028571	"1/60"	12249.78	162.97	2204.34
55	DR64	33	0.030303	"1/64"	12249.07	169.77	2206.22
56	DR68	31	0.032258	"1/68"	12251.25	167.77	2203.39
57	DR72	30	0.033333	"1/72"	12250.96	167.00	2204.25
58	DR76	28	0.035714	"1/76"	12248.81	164.08	2206.89
59	DR80	27	0.037037	"1/77"	12250.38	161.82	2204.00
60	DR84	26	0.038462	"1/84"	12252.75	161.93	2200.63
61	DR88	25	0.040000	"1/88"	12251.42	162.87	2202.85
62	DR92	24	0.041667	"1/92"	12251.7	165.57	2203.02
63	DR96	23	0.043478	"1/96"	12250.54	167.69	2204.69
64	DR100	22	0.045455	"1/100"	12250.27	161.35	2204.50

Table C-3

Original Data of the Well DBM

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ deg)
			3500.40	6.57	231.29	4080.10	29.45	221.64
0.00	0.00	0.00	3550.20	8.38	229.90	4090.10	30.19	222.06
100.30	0.52	318.56	3600.20	12.41	231.08	4100.00	31.02	222.68
200.20	0.57	320.00	3650.10	14.09	232.01	4110.00	31.76	223.27
300.10	0.57	317.22	3700.20	15.50	227.45	4120.00	32.69	223.81
400.30	0.53	316.32	3710.10	15.96	226.77	4130.10	33.54	224.26
500.40	0.62	313.89	3720.10	16.32	226.19	4140.10	34.37	224.42
600.20	0.68	313.10	3730.10	16.88	225.27	4160.10	34.89	225.05
700.50	0.64	322.99	3740.00	17.59	224.76	4170.00	35.11	225.60
800.50	0.79	323.80	3750.10	18.19	224.26	4180.10	35.62	225.66
900.30	0.94	311.08	3760.70	18.85	224.11	4190.10	36.04	225.62
1000.50	1.27	317.16	3770.10	19.75	224.05	4200.00	36.34	225.53
1100.20	2.64	330.93	3780.10	20.49	223.92	4210.10	36.28	225.53
1200.50	3.15	329.91	3790.20	21.17	223.68	4220.10	36.32	225.70
1300.10	3.87	329.43	3800.10	21.86	223.48	4230.10	36.21	225.68
1400.40	3.78	332.55	3810.20	22.70	223.42	4240.00	36.20	225.74
1500.30	4.06	334.12	3820.10	23.63	223.66	4250.00	36.14	225.89
1600.20	4.26	333.98	3830.10	24.49	223.97	4260.20	36.12	226.02
1700.40	4.21	332.19	3840.70	25.18	224.24	4270.20	36.04	226.07
1800.50	3.99	332.83	3850.10	25.33	224.25	4280.30	36.01	226.18
2000.30	3.94	334.83	3860.00	25.06	223.91	4290.10	35.97	226.32
2100.10	3.94	338.03	3870.00	24.32	223.36	4300.20	36.07	226.36
2200.10	3.87	342.13	3880.10	23.76	222.84	4310.10	35.96	226.51
2300.20	3.94	346.51	3890.00	23.24	222.55	4320.10	35.96	226.62
2400.20	4.20	346.59	3900.20	23.00	222.00	4330.00	35.99	226.69
2500.20	4.36	347.78	3910.00	23.13	221.95	4340.20	35.89	226.71
2600.90	4.49	348.15	3920.10	23.20	221.24	4350.10	36.02	226.79
2700.30	4.62	350.04	3930.10	23.12	219.89	4360.80	35.79	226.89
2800.20	4.86	349.66	3940.00	22.86	218.04	4370.20	35.90	227.01
2900.40	5.04	348.63	3950.00	22.73	216.59	4380.10	35.76	227.04
3000.30	5.44	348.69	3960.20	22.83	216.15	4390.00	35.69	227.17
3050.30	5.71	348.34	3970.20	23.02	216.05	4400.00	35.73	227.25
3100.30	5.23	341.11	3980.00	23.35	216.14	4410.10	35.73	227.30
3150.40	6.76	323.91	3990.10	24.14	216.04	4420.00	35.67	227.45
3200.50	7.62	322.52	4010.20	26.28	216.17	4430.10	35.81	227.44
3250.30	6.42	313.37	4020.10	26.85	216.76	4440.20	35.60	227.52
3300.30	7.01	313.26	4030.00	27.34	217.88	4450.20	35.71	227.66
3350.10	6.02	302.81	4040.00	27.66	219.55	4460.00	35.68	227.76
3400.10	5.71	275.81	4060.10	28.28	221.65	4470.20	35.56	227.81
3450.30	4.87	245.33	4070.20	28.81	221.66	4480.00	35.55	227.84

Table C-3

Original Data of the Well DBM
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ deg)
4490.10	35.62	228.01	4890.00	35.77	229.12	5290.10	42.18	255.08
4500.10	35.59	228.05	4900.10	35.84	229.18	5300.20	42.22	255.09
4510.10	35.48	228.10	4910.10	35.95	229.20	5310.10	42.23	255.10
4520.10	35.52	228.13	4920.20	36.01	229.21	5320.00	42.17	255.20
4530.10	35.46	228.23	4930.10	36.05	229.23	5330.20	42.25	255.43
4540.10	35.34	228.19	4940.10	36.15	229.26	5340.10	42.37	255.64
4550.20	35.38	228.31	4950.00	36.35	229.29	5350.00	42.33	255.66
4560.00	35.41	228.34	4960.10	36.49	229.41	5360.10	42.37	255.90
4570.00	35.59	228.44	4970.10	36.60	229.54	5370.20	42.43	256.07
4580.10	35.43	228.47	4980.20	36.66	229.53	5380.20	42.46	256.17
4590.10	35.35	228.62	4990.20	36.83	229.53	5390.10	42.58	256.33
4600.00	35.47	228.57	5000.00	36.93	229.57	5400.10	42.59	256.48
4610.20	35.53	228.57	5010.10	37.24	229.82	5410.10	42.63	256.53
4620.00	35.53	228.60	5020.00	37.54	230.49	5420.10	42.73	256.64
4630.00	35.59	228.52	5030.10	38.15	231.43	5430.00	42.73	256.84
4640.20	35.53	228.52	5040.00	38.72	232.45	5440.00	42.79	256.93
4650.00	35.69	228.41	5050.30	39.25	233.88	5450.20	42.82	257.04
4660.20	35.65	228.43	5060.00	39.64	235.41	5460.10	42.80	257.14
4670.00	35.82	228.43	5070.20	39.98	236.96	5470.30	42.86	257.23
4680.60	35.86	228.43	5080.11	40.46	238.36	5480.10	42.91	257.43
4690.20	35.86	228.50	5090.00	41.00	239.69	5490.00	42.96	257.45
4700.20	35.83	228.46	5100.00	41.40	240.65	5500.10	43.08	257.49
4710.10	35.77	228.44	5110.10	41.60	241.02	5510.10	43.23	257.55
4720.10	35.70	228.47	5120.10	41.69	241.26	5520.20	43.24	257.58
4730.10	35.64	228.37	5130.00	41.97	241.86	5530.10	43.23	257.69
4740.30	35.61	228.39	5140.00	42.29	242.60	5540.20	43.38	257.82
4750.20	35.60	228.36	5150.10	42.71	243.26	5550.10	43.39	257.87
4760.10	35.40	228.36	5160.10	42.86	244.08	5560.20	43.45	257.03
4770.20	35.44	228.47	5170.00	42.82	244.83	5570.60	43.51	258.25
4780.20	35.47	228.63	5180.10	42.95	245.88	5580.20	43.61	258.36
4790.00	35.39	228.55	5190.10	42.72	246.85	5590.10	43.56	258.55
4800.20	35.30	228.64	5200.00	42.46	247.79	5600.10	43.66	258.58
4810.20	35.26	228.77	5210.10	42.44	248.90	5610.00	43.76	258.75
4820.10	35.34	228.96	5220.00	42.25	250.12	5620.00	43.79	258.94
4830.10	35.36	229.06	5230.30	42.05	251.22	5630.10	43.94	259.07
4840.10	35.37	229.00	5240.10	41.98	252.16	5640.20	43.97	259.17
4850.00	35.59	229.21	5250.00	41.59	253.08	5650.20	44.10	259.38
4860.00	35.54	229.24	5260.10	41.37	253.84	5660.10	44.13	259.41
4870.00	35.68	229.29	5270.20	41.39	254.59	5670.30	44.15	259.49
4880.10	35.75	229.23	5280.00	41.87	254.94	5680.20	44.23	259.59

Table C-3

Original Data of the Well DBM
(continued)

MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ (deg)	MD (ft)	INL (deg)	AZ deg)
5690.10	44.26	259.63	5860.00	46.67	259.00	6030.20	49.67	257.84
5700.00	44.43	259.75	5870.00	46.92	258.91	6040.10	49.82	257.88
5710.20	44.41	259.79	5880.30	47.10	258.87	6050.10	49.93	257.88
5720.10	44.58	259.83	5890.10	47.14	258.68	6060.10	50.07	258.01
5730.20	44.58	259.83	5900.10	47.32	258.50	6070.00	50.26	258.16
5740.10	44.53	259.73	5910.10	47.48	258.27	6080.10	50.29	258.06
5750.10	44.58	259.75	5920.00	47.64	258.08	6090.10	50.47	258.15
5760.10	44.41	259.76	5930.20	48.03	257.81	6100.20	50.59	258.24
5770.10	44.47	259.64	5940.10	48.17	257.65	6110.10	50.66	258.30
5780.00	44.63	259.59	5950.00	48.45	257.59	6120.00	50.78	258.44
5790.10	44.78	259.67	5960.20	48.59	257.58	6130.10	50.94	258.46
5800.30	45.15	259.57	5970.10	48.84	257.55	6140.10	51.06	258.53
5810.10	45.14	259.34	5980.00	48.91	257.49	6150.00	51.18	258.60
5820.10	45.72	259.22	5990.10	49.11	257.67	6160.00	51.47	258.63
5830.10	46.07	259.19	6000.10	49.34	257.74	6170.00	51.14	258.53
5840.00	46.35	259.12	6010.10	49.43	257.60			
5850.00	46.55	259.10	6020.00	49.56	257.73			

Table C-4

Location of the Bottom of the Bore Hole for Twenty-six Reduced Data Sets of the Well DBM

NO	FL-NAME (.xls)	PORTION	STA #	1/STA 1/#	TVD ft	N+/S- ft	E+/W- ft
1	DBR0	"1"	288	0.0035	5618.36	-543.64	-1395.83
2	DMOD9-10	"9/10"	260	0.0038	5618.34	-542.87	-1395.85
3	DMOD8-9	"8/9"	257	0.0039	5618.41	-544.70	-1395.76
4	DMOD7-8	"7/8"	253	0.0040	5618.33	-542.86	-1396.99
5	DMOD6-7	"6/7"	247	0.0040	5618.55	-542.75	-1394.52
6	DMOD5-6	"5/6"	241	0.0041	5618.76	-544.85	-1394.28
7	DMOD4-5	"4/5"	231	0.0043	5618.19	-541.72	-1396.43
8	DMOD3-4	"3/4"	217	0.0046	5618.43	-544.52	-1396.50
9	DMOD2-3	"2/3"	193	0.0052	5618.73	-544.44	-1394.93
10	DMOD1	"1/2"	145	0.0069	5618.96	-545.22	-1393.33
11	DMOD2	"1/3"	97	0.0103	5618.51	-542.08	-1395.40
12	DMOD3	"1/4"	73	0.0137	5619.04	-541.00	-1397.80
13	DMOD4	"1/5"	59	0.0169	5618.40	-546.38	-1392.14
14	DMOD5	"1/6"	49	0.0204	5618.01	-538.17	-1402.28
15	DMOD6	"1/7"	42	0.0238	5618.60	-543.23	-1404.87
16	DMOD7	"1/8"	37	0.0270	5622.62	-553.35	-1400.31
17	DMOD8	"1/9"	33	0.0303	5621.44	-558.00	-1400.57
18	DMOD9	"1/10"	30	0.0333	5622.23	-577.59	-1381.54
19	DMOD10	"1/11"	28	0.0357	5616.18	-540.35	-1427.68
20	DMOD11	"1/12"	25	0.0400	5620.39	-543.22	-1415.67
21	DMOD12	"1/13"	24	0.0417	5622.78	-573.22	-1401.06
22	DMOD13	"1/14"	22	0.0455	5618.50	-569.07	-1421.73
23	DMOD14	"/15"	21	0.0476	5614.76	-541.01	-1414.04
24	DMOD15	"1/16"	19	0.0526	5617.66	-531.23	-1455.41
25	DMOD16	"1/17"	18	0.0556	5616.98	-552.91	-1457.81
26	DMOD17	"1/18"	17	0.0588	5619.22	-561.44	-1452.59
27	DMOD18	"1/19"	16	0.0625	5624.15	-644.37	-1418.48

Notes

First # at: 0 ft(MD), 0 deg(INL), 0 deg(AZM)

Last# at: 6,170 ft (MD), 51.14 deg (INCL), 258.53 deg (AZM)

Table C-5

An Economic Evaluation of The Well DRL

Ns #	1/Ns	Lc (ft)	Rc (ft)	Rev ($)	Cost ($)	Profit ($)
1958	0.000511	0.074	659.926	1250841	143894	1106947
1933	0.000517	0.075	659.925	1250838	142074	1108764
1928	0.000519	0.075	659.925	1250837	141709	1109127
1921	0.000521	0.075	659.925	1250836	141200	1109636
1912	0.000523	0.075	659.925	1250834	140544	1110290
1895	0.000528	0.076	659.924	1250832	139306	1111526
1882	0.000531	0.077	659.923	1250830	138360	1112470
1863	0.000537	0.077	659.923	1250827	136976	1113851
1857	0.000539	0.078	659.922	1250826	136539	1114287
1852	0.00054	0.078	659.922	1250825	136175	1114650
1845	0.000542	0.078	659.922	1250824	135665	1115159
1838	0.000544	0.079	659.921	1250823	135156	1115667
1830	0.000546	0.079	659.921	1250822	134573	1116249
1821	0.000549	0.079	659.921	1250820	133918	1116902
1810	0.000552	0.080	659.920	1250818	133117	1117702
1797	0.000556	0.080	659.920	1250816	132170	1118646
1783	0.000561	0.081	659.919	1250814	131151	1119663
1765	0.000567	0.082	659.918	1250811	129840	1120971
1743	0.000574	0.083	659.917	1250807	128238	1122569
1716	0.000583	0.084	659.916	1250802	126272	1124530
1681	0.000595	0.086	659.914	1250795	123723	1127072
1634	0.000612	0.088	659.912	1250786	120300	1130485
1569	0.000637	0.092	659.908	1250772	115567	1135205
1471	0.00068	0.098	659.902	1250749	108431	1142318
1308	0.000765	0.110	659.890	1250702	96561	1154141
981	0.001019	0.147	659.853	1250563	72749	1177814
655	0.001527	0.220	659.780	1250285	49010	1201275
492	0.002033	0.293	659.707	1250009	37141	1212868
394	0.002538	0.366	659.634	1249732	30004	1219728
329	0.00304	0.439	659.561	1249458	25271	1224187
282	0.003546	0.512	659.488	1249181	21849	1227333
247	0.004049	0.584	659.416	1248907	19300	1229607
220	0.004545	0.656	659.344	1248635	17334	1231301
197	0.005076	0.732	659.268	1248345	15659	1232686
166	0.006024	0.869	659.131	1247827	13402	1234425
142	0.007042	1.016	658.984	1247271	11654	1235617
125	0.008	1.154	658.846	1246748	10416	1236332
111	0.009009	1.300	658.700	1246197	9396	1236800
100	0.01	1.443	658.557	1245656	8595	1237060

Table C-5

An Economic Evaluation of The Well DRL
(continued)

Ns #	1/Ns	Lc (ft)	Rc (ft)	Rev ($)	Cost ($)	Profit ($)
91	0.010989	1.586	658.414	1245116	7940	1237176
84	0.011905	1.718	658.282	1244616	7430	1237186
78	0.012821	1.850	658.150	1244116	6993	1237123
72	0.013889	2.004	657.996	1243534	6557	1236977
68	0.014706	2.122	657.878	1243088	6265	1236823
62	0.016129	2.327	657.673	1242312	5828	1236484
57	0.017544	2.532	657.468	1241541	5464	1236077
53	0.018868	2.723	657.277	1240819	5173	1235647
49	0.020408	2.945	657.055	1239980	4882	1235099
46	0.021739	3.137	656.863	1239256	4663	1234592
43	0.023256	3.356	656.644	1238430	4445	1233985
41	0.02439	3.520	656.480	1237813	4299	1233513
39	0.025641	3.700	656.300	1237132	4153	1232979
37	0.027027	3.900	656.100	1236378	4008	1232370
35	0.028571	4.123	655.877	1235538	3862	1231676
33	0.030303	4.373	655.627	1234597	3717	1230881
31	0.032258	4.655	655.345	1233535	3571	1229964
30	0.033333	4.810	655.190	1232951	3498	1229453
28	0.035714	5.154	654.846	1231658	3352	1228306
27	0.037037	5.345	654.656	1230940	3280	1227660
26	0.038462	5.550	654.450	1230167	3207	1226960
25	0.04	5.772	654.228	1229333	3134	1226199
24	0.041667	6.013	653.987	1228429	3061	1225368
23	0.043478	6.274	653.726	1227447	2988	1224459
22	0.045455	6.559	653.441	1226377	2916	1223461

Rig cost=	750 $/hour	Fishing=	5000 $/day
MWD =	3400 $/day	Tools =	3000 $/day
1 STB =	14 $	Cmtng=	7500 $/day
Radius=	660 ft	Height=	20 ft
Abdning=	1000000 $		

Reservoir properties : (aasumed that a reservoir type is a cylindrical)

POR=	0.10 fraction	Bo=	1.2 RB/STB
Sw =	0.45 fraction	Rec-Fac=	0.40 fraction

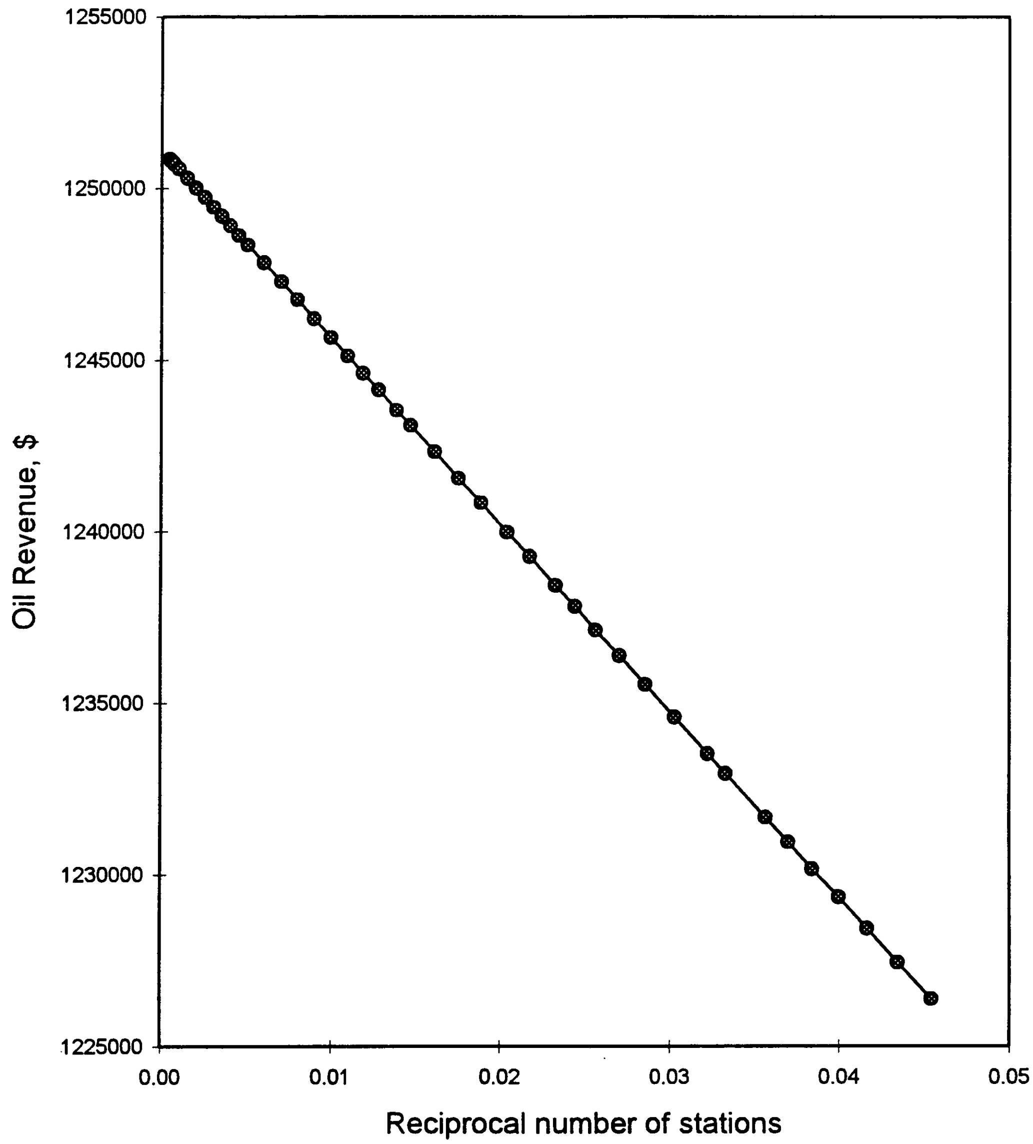

Figure C-1. Oil Revenue of The Well DRL

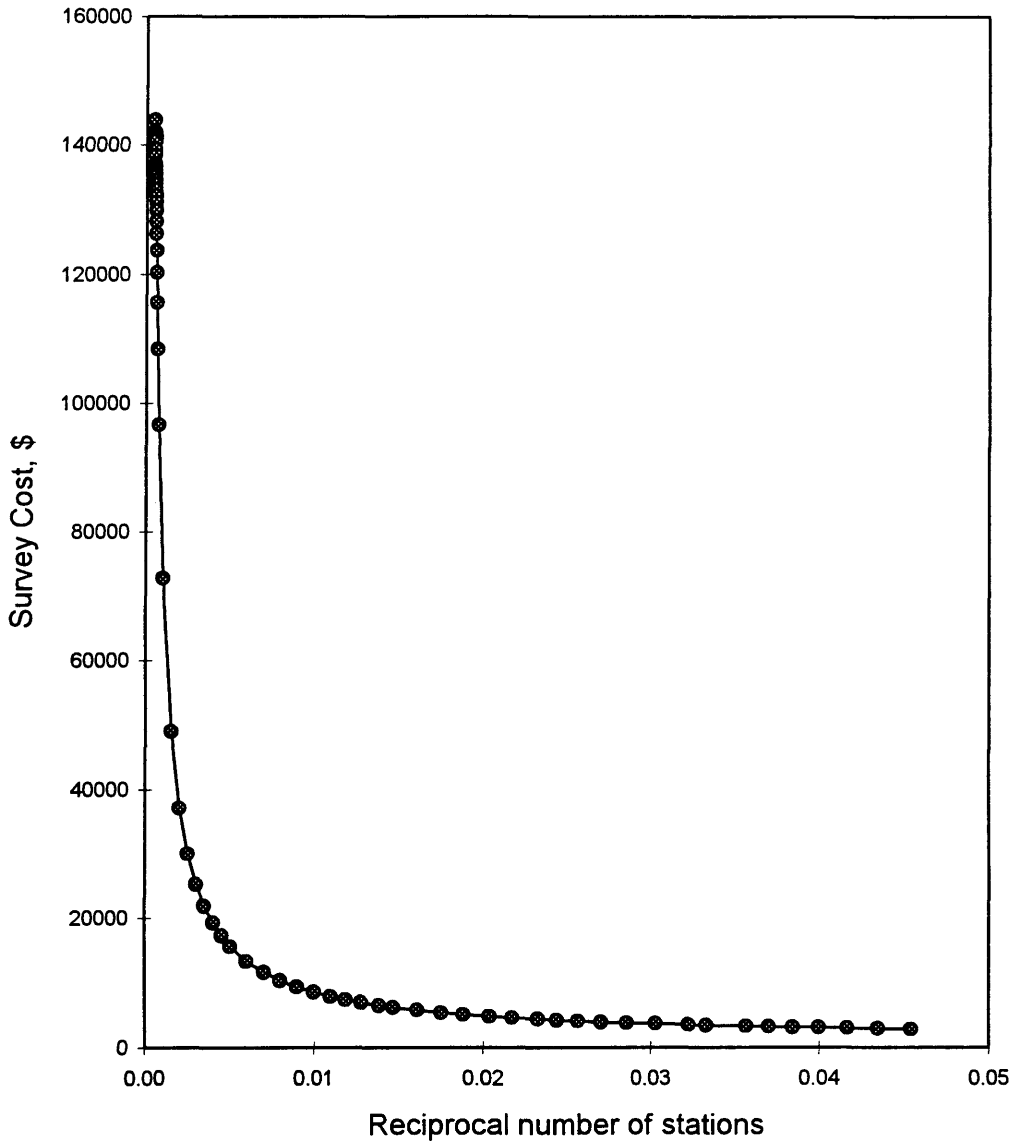

Figure C-2. Survey Cost of The Well DRL

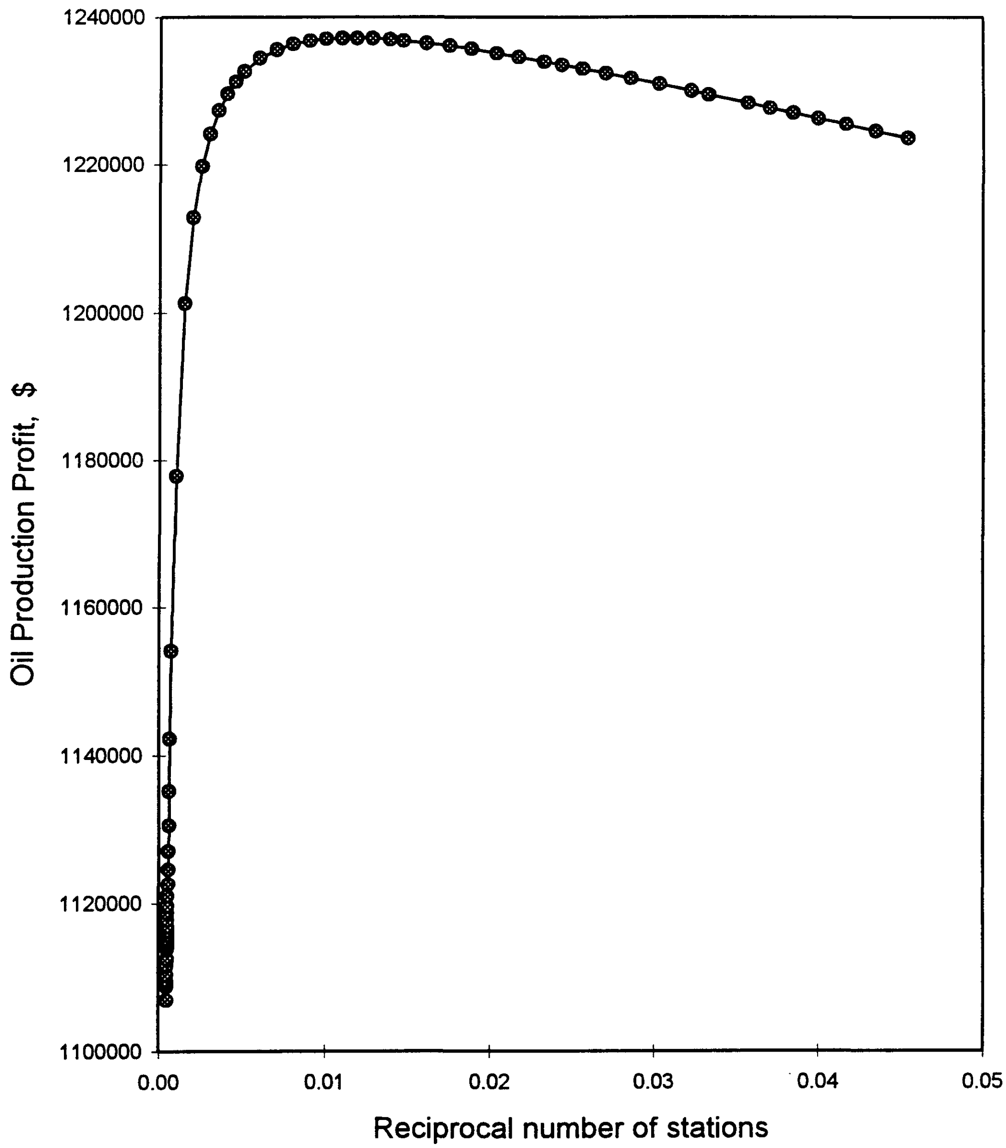

Figure C-3. Profit of The Well DRL

Table C-6

An Economic Evaluation of The Well DBM

Ns #	1/Ns	Lc (ft)	Rc (ft)	Rev ($)	Cost ($)	Profit ($)
288	0.00347	3.36	656.64	1238399	22286	1216114
283	0.00353	3.42	656.58	1238175	21921	1216253
279	0.00358	3.47	656.53	1237990	21630	1216360
274	0.00365	3.54	656.46	1237751	21266	1216485
269	0.00372	3.60	656.40	1237503	20902	1216601
266	0.00376	3.64	656.36	1237350	20683	1216666
262	0.00382	3.70	656.30	1237140	20392	1216748
260	0.00385	3.73	656.27	1237033	20247	1216786
257	0.00389	3.77	656.23	1236869	20028	1216841
253	0.00395	3.83	656.17	1236644	19737	1216907
247	0.00405	3.92	656.08	1236294	19300	1216994
241	0.00415	4.02	655.98	1235926	18863	1217063
231	0.00433	4.19	655.81	1235270	18135	1217135
217	0.00461	4.46	655.54	1234251	17115	1217135
193	0.00518	5.02	654.98	1232161	15368	1216793
145	0.00690	6.68	653.32	1225917	11872	1214044
97	0.01031	9.99	650.01	1213539	8377	1205162
73	0.01370	13.27	646.73	1201309	6629	1194680
59	0.01695	16.42	643.58	1189638	5610	1184028
49	0.02041	19.77	640.23	1177281	4882	1172399
42	0.02381	23.07	636.93	1165193	4372	1160821
37	0.02703	26.19	633.82	1153815	4008	1149808
33	0.03030	29.36	630.64	1142288	3717	1138572
30	0.03333	32.29	627.71	1131678	3498	1128179
28	0.03571	34.60	625.40	1123375	3352	1120023
25	0.04000	38.75	621.25	1108508	3134	1105374
24	0.04167	40.37	619.63	1102753	3061	1099692
22	0.04545	44.04	615.96	1089729	2916	1086814
21	0.04762	46.14	613.86	1082322	2843	1079479
19	0.05263	50.99	609.01	1065265	2697	1062568
18	0.05556	53.82	606.18	1055377	2624	1052753
17	0.05882	56.99	603.01	1044381	2551	1041830
16	0.06250	60.55	599.45	1032079	2479	1029601

Rig cost=	750 $/hour	Fishing=	5000 $/day
MWD =	3400 $/day	Tools =	3000 $/day
1 STB=	14 $	Cemntg=	7500 $/day
Radius=	660 ft	Height=	20 ft
Abandnd=	1000000 $		
POR=	0.10 frac	Bo=	1.2 RB/STB
Sw =	0.45 frac	Rec-Fac=	0.40 frac

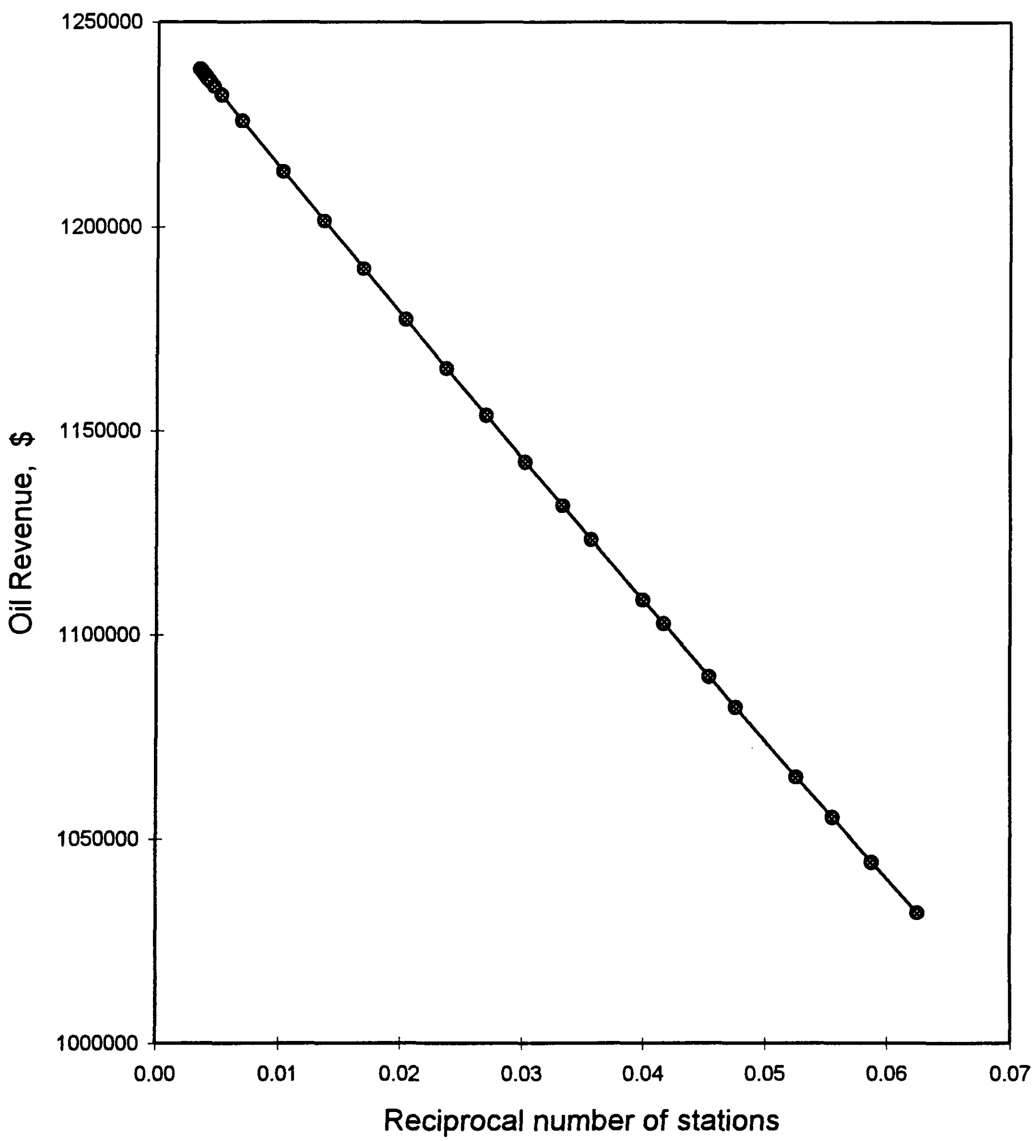

Figure C-4. Oil Revenue of The Well DBM

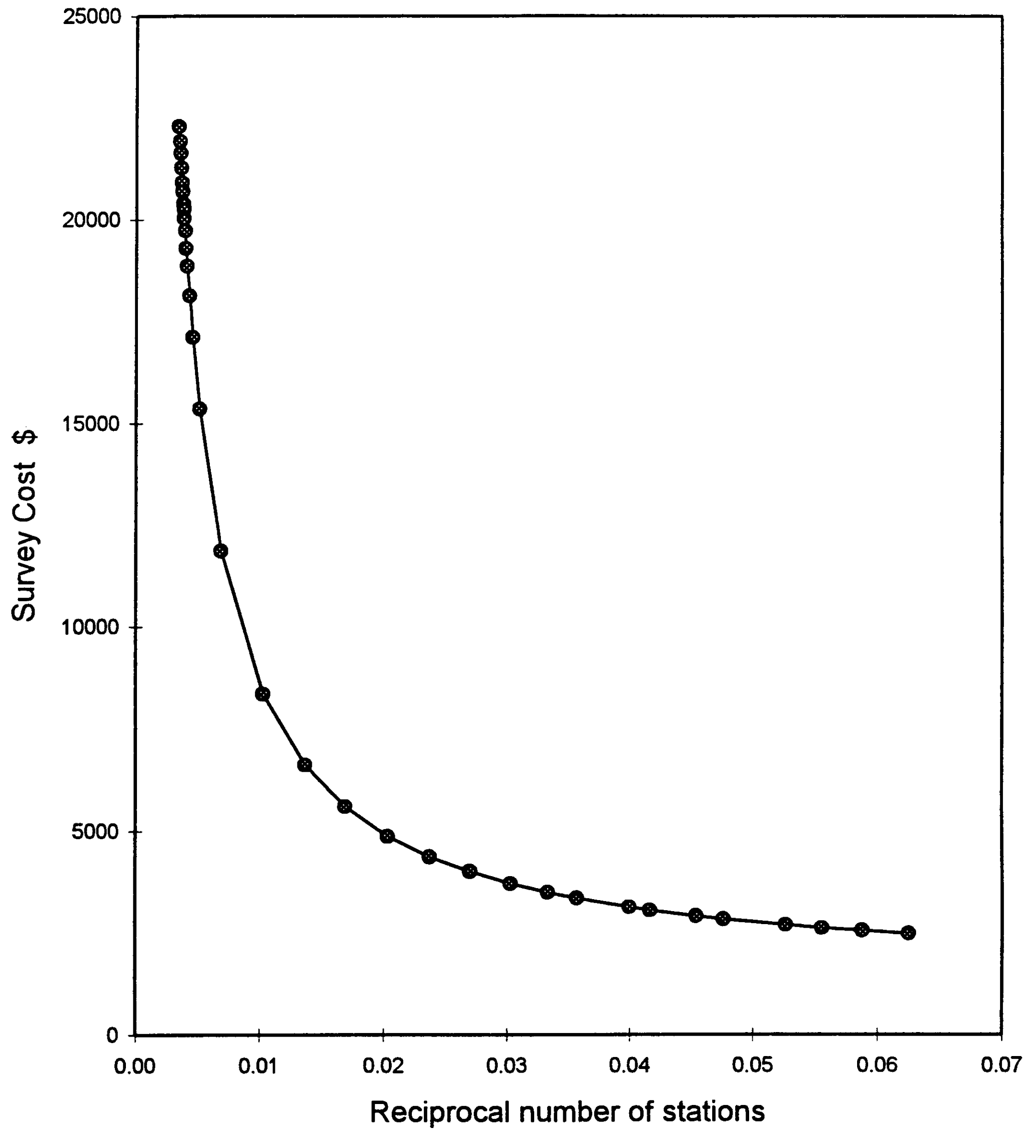

Figure C-5. Survey Cost of The Well DBM

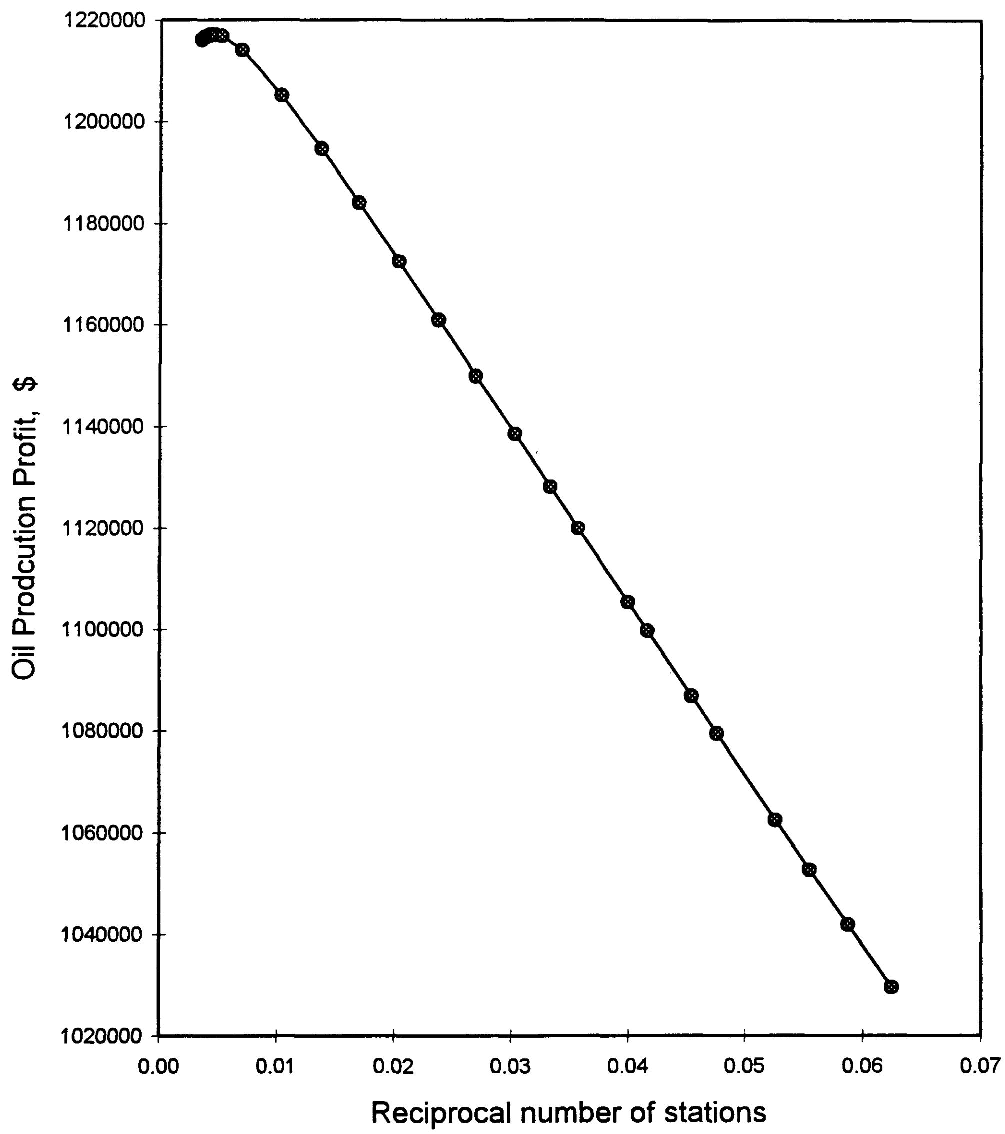

Figure C-6. Profit of The Well DBM

APPENDIX D

PROCEDURE FOR SELECTING DIRECTIONAL SURVEY SPACING

1. Transpose raw survey data from two real field wells DRL and DBM (table C-1 and C-3 refer to appendix C) such as measured depth, inclinations, azimuths to Cartesian coordinates, azimuths and distances with Mitchell[1] Engineering's directional drilling software.
2. Draw section view figures (true vertical depth on ordinate axis, departure on abscissa axis on Figures A-1 and A-3) and plane view figures (north(+)/south(-) direction on ordinate axis and east(+)/west(-) on abscissa on Figures A-2 and A-4) to see directional well types a for each data from step 1.
3. Delete a specified station with systematic reduction in the stations from a sequence of station. Sixty-four and twenty-seven surveys were generated for well DRL and DBM respectively (table C-2 and C-4).
4. Construct a plot of bottom hole location (true vertical depth, north/south and east/west) on the ordinate and the reciprocal number of the stations in a series of reduced surveys on the abscissa and extrapolate the resulting data points to ordinate axis. The intersection of the extrapolation of the data points and the ordinate represents the value which would have been attained with

a survey which contained and infinite number of stations. The rational supporting this procedure for ascertaining the best bottom hole location is that a survey which contains most the stations is the most precise survey as can be seen on Figures B-1, B-2, B-3 and B-5, B-6, B-7 for well DRL and DBM respectively.

5. A triangle can be drawn on each figure on step 4, write equations for the upper and lower boundary lines of the value of H as functions of $1/N_s$. In this research these lines were practically estimated by engineering judgement. Substract the lower boundary equation from the upper boundary equation given in each figure. Call the resulting functions as $H_{N/S}$, $H_{E/W}$ for which are the length of the spread between the two lines which encompass the plotted points.
6. A composite bottom hole location was derived from combining North/South bottom hole location (Figure B-2) with East/West bottom hole location (Figure B-3). H_c can be calculated as formulated as H_c = sqrt($(H_{N/S})$^2+$(H_{E/W})$^2) as functions of 1/Ns. Then Lc was calculated as $L_c = H_c/2$.
7. The stability value can be formulated as L_c/D_c from step 6 for a certain number of stations and illustrated as L_c/D_c on the ordinate and reciprocal number of stations on the

abscissa on Figures B-4 and B-18 for well DRL and DBM respectively.

8. The hydrocarbon production model for every L_c (distance from the center of the reservoir for representing every reduced survey) can be calculated from equation 4. The revenue from this hydrocarbon production can also be calculated from equation 5. Therefore, a revenue profile for each well can be made by plotting the revenue on the ordinate and the reciprocal number of the stations in a series of reduced surveys on the abscissa as seen on figures C-1 and C-4 for well DRL and DBM respectively.
9. The survey cost was calculated from equation 14 for every systematically reduced surveys. Then, a survey cost profile for a well can be presented by drawing the survey cost on the ordinate and the reciprocal number of the stations in a series of reduced surveys on the abscissa as seen on figures C-2 and C-5.
10. The profit of a well can be calculated by subtracting a revenue from step 9 with a survey cost from step 10. A profit profile can also be plotted by drawing the profit on the ordinate and the reciprocal number of the stations in a series of reduced surveys on the abscissa as seen on figures C-3 and C-6.

11. The maximum profit can be defined by indicating the highest point (turning point) from Figures C-3 and C-6 on step 10.
12. The selection of directional survey spacing can be performed by dividing a well depth surveyed with the value of survey station at the maximum profit from step 11.