337
13 19

44. 2599

RHO-BWI-ST-1

Geophysical Logging and Hydrologic Testing of Deep Basalt Flows in the Rattlesnake Hills Well Number One

R. E. Gephart
P. A. Eddy
R. A. Deju

MASTER

January 1979

Prepared for the United States
Department of Energy
Under Contract EY-77-C-06-1030

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

Rockwell International

Rockwell Hanford Operations
Energy Systems Group
Richland, WA 99352

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Rockwell International

Rockwell Hanford Operations
Energy Systems Group
Richland, WA 99352

NOTICE

This Report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their Employees, nor any of their Contractors, Subcontractors, or their Employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

AVAILABLE FROM THE
NATIONAL TECHNICAL INFORMATION SERVICE
SPRINGFIELD, VA. 22161

PRICE: MICROFICHE: \$3.00

PAPER COPY: ~~\$0.50~~

7.25

GEOPHYSICAL LOGGING AND HYDROLOGIC TESTING
OF DEEP BASALT FLOWS IN THE
RATTLESNAKE HILLS WELL NUMBER ONE

January 1979

R. E. Gephart
Basalt Hydrology Unit
Research Department

R. A. Deju
Program Director
Basalt Waste Isolation Program

Rockwell International
Rockwell Hanford Operations
Energy Systems Group
Richland, Washington 99352

and

P. A. Eddy
Occupational and Environmental Safety Department
Pacific Northwest Laboratory
Richland, Washington 99352

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

A B S T R A C T

Geophysical logging and hydrologic testing were conducted in the Rattlesnake Hills Well Number One located along the western boundary of the Hanford Site in south-central Washington. Three-dimensional velocity, Seisviewer and caliper logging were completed across 2,000 feet of basalt rock within the Wanapum and Grande Ronde formations. Drillstem testing focused along a 250-foot interval of the Grande Ronde Formation.

Individual high- (~ 2.7 - 2.9 grams per cubic centimeter) and low-density (~ 2.3 - 2.6 grams per cubic centimeter) basalt zones within the Wanapum Formation are generally less than 50 feet thick. Within the estimated thickness of the Grande Ronde Formation, 85 percent of the low-density zones are less than 50 feet thick, compared to 55 percent of those of higher density. The Grande Ronde Formation has 13 high-density zones varying in thickness from 51 to 230 feet. Logging data suggest the thicknesses of low-density zones are independent of the thicknesses of the associated and underlying higher density columnar basalts.

Eleven drillstem tests were conducted across selected intervals within the Grande Ronde Formation. Hydraulic conductivity values calculated for the low-density basalt zones ranged between 1.7×10^{-7} and 3.8×10^{-9} centimeters per second; those for high-density zones were between 1.1×10^{-8} and 4.7×10^{-9} centimeters per second.

TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION	5
OBJECTIVE	5
WELL LOCATION	5
WELL HISTORY	5
PHYSIOGRAPHIC SETTING	7
GEOLOGIC SETTING	7
GEOPHYSICAL LOGGING	12
INTRODUCTION	12
GENERAL DESCRIPTION OF GEOPHYSICAL LOGS	13
CALIPER LOG	13
THREE-DIMENSIONAL VELOCITY LOG	14
SEISVIEWER	14
DOWNHOLE CAMERA	15
INTERPRETATION	15
DRILLSTEM TESTING	26
INTRODUCTION	26
GENERAL THEORY	28
WORK DESCRIPTION	32
INTERPRETATION	35
HYDRAULIC CONDUCTIVITY	35
SKIN FACTOR	38
STATIC WATER PRESSURES	38
RADIUS OF INFLUENCE	39
CONCLUSIONS	39
ACKNOWLEDGMENTS	41
REFERENCES	41
DISTRIBUTION	44
APPENDIX A - GEOPHYSICAL LOG TRACES	50
APPENDIX B - DRILLSTEM TEST DATA	70

LIST OF FIGURES

		<u>Page</u>
FIGURE 1	MAP OF HANFORD SITE AND SURROUNDING AREA SHOWING LOCATION OF TEST WELL	6
FIGURE 2	OUTLINE OF THE COLUMBIA RIVER BASALT GROUP	8
FIGURE 3	STRATIGRAPHY OF THE PASCO BASIN	9
FIGURE 4	SCHEMATIC OF WELL RSH-1	11
FIGURE 5	THICKNESS OF LOW-DENSITY ZONES WITHIN THE COLUMBIA RIVER BASALT GROUP PENETRATED BY WELL RSH-1	17
FIGURE 6	THICKNESS OF HIGH-DENSITY ZONES WITHIN THE COLUMBIA RIVER BASALT GROUP PENETRATED BY WELL RSH-1	18
FIGURE 7	HISTOGRAM SHOWING THE FREQUENCY OF LOW-DENSITY ZONE THICKNESSES WITHIN THE GRANDE RONDE FORMATION	20
FIGURE 8	HISTOGRAM SHOWING THE FREQUENCY OF HIGH-DENSITY ZONE THICKNESSES WITHIN THE GRANDE RONDE FORMATION	21
FIGURE 9	VARIATION OF ZONE DENSITY THICKNESSES WITHIN THE COLUMBIA RIVER BASALT GROUP	22
FIGURE 10	GEOPHYSICAL LOG TRACES ACROSS THE INTERVAL 2,600 TO 2,860 FEET BELOW GROUND LEVEL	24
FIGURE 11	GENERALIZED DIAGRAM OF DRILLSTEM EQUIPMENT	27
FIGURE 12	DRILLSTEM PRESSURE RESPONSE FOR SINGLE FLOW PERIOD	29
FIGURE 13	DOWNHOLE POSITION OF SEVEN DRILLSTEM TESTS	37

LIST OF TABLES

TABLE I	DEPTHS TO SPECIFIC BASALT INTERVALS LATER HYDROLOGICALLY TESTED	25
TABLE II	LISTING OF ALL DRILLSTEM TESTS CONDUCTED	33
TABLE III	VALUES OF HYDRAULIC CONDUCTIVITY AND SKIN FACTOR	36
TABLE IV	VALUES FOR RADIUS OF INFLUENCE	40

INTRODUCTION

OBJECTIVE

Geophysical logging and hydrologic testing of the Rattlesnake Hills Well Number One (RSH-1) were conducted to study the geohydrologic characteristics of selected portions of the Grande Ronde Formation of the Columbia River Basalt Group. Well RSH-1 is one of several boreholes in and around the Hanford Site from which downhole data have been collected on the Columbia River Basalt Group.

WELL LOCATION

Well RSH-1 is located west of the Hanford Site about 15 miles north of the town of Prosser, Washington and 12 miles northeast of Sunnyside, Washington (Figure 1). The exact location is 300 feet north and 300 feet west of the southeast corner of Section 15, Township 11 North, Range 24 East of the Willamette Meridian. The land surface elevation is 2,889 feet above mean sea level. Travel to RSH-1 is by road from the south via the towns of Prosser and Grandview. Because the well is located on private property, access was arranged through a lease agreement with the owner, Mr. H. G. Anderson.

WELL HISTORY

Well RSH-1 was drilled in 1957 and 1958 for the Standard Oil Company of California by Miracle and Wooster Drilling Company of Vernal, Utah. The well is 10,655 feet deep and was drilled to accept 18-1/2-inch casing for the first 22 feet, and 13-3/8-inch casing to 603 feet (all further depth references use ground level as the common datum plane). A 9-7/8-inch open hole was drilled from 603 feet to 8,418 feet and a 9-inch open hole from 8,418 feet to 10,655 feet. In April 1958, a cement plug was installed from 540 feet to 690 feet and the well was abandoned. In May 1967, Battelle-Northwest contracted Taylor Drilling Company of Chehalis, Washington to clean the well. The original plug was drilled out and drilling fluid was recirculated to 9,157 feet. The well was then geophysically logged, side-hole samples were taken by Schlumberger Well Services Corporation of West Sacramento, California, and 7 drillstem tests were conducted by Cook Testers of Long Beach, California. The well was then replugged between 500 and 658 feet. The results of this work were documented.⁽¹⁾

V7812-1.1

FIGURE 1

MAP OF HANFORD SITE AND SURROUNDING AREA
SHOWING LOCATION OF TEST WELL

PHYSIOGRAPHIC SETTING

The well is located near the anticlinal axis of the Rattlesnake Hills, which is an east-west-trending basalt ridge rising 3,000 feet above the valley floor. This ridge separates the Yakima Valley from the Dry Creek Valley. The ridge extends eastward from the Cascade Mountains to the Yakima River south of Yakima, Washington as Ahtanum Ridge. Farther eastward, it is called Rattlesnake Hills before passing into a series of doubly plunging anticlines. The total length of the ridge is about 90 miles. The north flank is relatively steep; however, the south flank in which RSH-1 is located has a gentler slope.

GEOLOGIC SETTING

The Columbia River Basalt Group forms a layered rock mass covering approximately 60,000 square miles in parts of Washington, Oregon and Idaho to an average thickness of 1,600 feet (Figure 2).⁽²⁾ This accumulation of basalt resulted from the repeated eruption of molten rock from middle Miocene, approximately 16 million years before present, through early Miocene, approximately 8 million years before present.⁽³⁻⁶⁾ An estimated 99 percent of the basalts in the Columbia River Basalt Group were emplaced during a 3-million-year volcanic pulse occurring 16 to 13 million years before present.⁽⁷⁾

The Pasco Basin is one of several structural basins underlain by the Columbia River Basalt Group (Figure 2). However, the Pasco Basin is unique in that it contains a great accumulation of basalt having a minimum thickness of about 5,000 feet.⁽⁸⁻¹⁰⁾ Well RSH-1 is the deepest exploratory hole yet completed in the Pasco Basin. The basalt apparently overlies a series of older volcanic rocks of Eocene to Oligocene age.^(1,11)

The stratigraphic nomenclature of the Columbia River Basalt Group has recently been revised (Figure 3). In this revision, the group has been subdivided into three formations: the Saddle Mountains; the Wanapum; and the Grande Ronde which collectively constitute the Yakima Basalt Subgroup. Previously, these formations were known as the Upper, Middle and Lower Yakima basalts, respectively. These formations are, in turn, divided into various members and flows.

The subsurface stratigraphy of the Pasco Basin is reasonably well understood. It has been developed by correlating basalt strata between surface outcrops and core holes using petrographic, geochemical and

FIGURE 2

OUTLINE OF THE COLUMBIA RIVER BASALT GROUP

FIGURE 3

STRATIGRAPHY OF THE PASCO BASIN

geophysical data. Well RSH-1 was drilled through the Columbia River Basalt Group and into older rocks which were described as andesitic basalt.⁽¹⁾ The Saddle Mountains Formation forms the upper 475 feet of basalt section penetrated by RSH-1. The Wanapum Formation lies between 475 and 1,670 feet and is separated from the Grande Ronde Formation by a thin (less than 20 feet) section of Vantage Sandstone. The Grande Ronde Formation extends from a depth of 1,690 feet to approximately 5,000 feet (Figure 4). The exact depth of this lower boundary is still a subject of study.

Interpretations of deep tectonic structures within and beneath the Columbia River Basalt Group have been made using geologic, seismic, gravity, aeromagnetic and resistivity studies.⁽¹²⁻¹⁹⁾ The Columbia River Basalt Group thins toward the edges of the basin, resting unconformably on Mesozoic granitic rocks of the Okanogan Highlands to the north, pre-Cambrian to Mesozoic rocks in the Rocky Mountains to the east and mainly on folded Tertiary formations in the Blue Mountains and Cascade Mountains to the south and west.^(19,20) West-to-northwest-trending anticlinal ridges, such as the Rattlesnake Hills, developed above the floor of the aggrading basin during the waning stages of the basalt outpourings.⁽¹⁹⁾ Synclinal basins formed between these anticlines. The Yakima and Dry Creek valleys are two of these synclines.

Columnar joints are the most common intraflow structures within individual basalt flows. These formed from the cooling and shrinking of the original molten rock mass. Although the jointing shows considerable variability, both within and between flows, a typical flow usually has:

- (1) A lower zone (the colonnade), generally 25 to 50 percent of the thickness of the entire flow and consisting of nearly symmetrical columnar joints that define hexagonal columns oriented perpendicular to the flow top;
- (2) An upper zone (the entablature), generally 50 to 75 percent of the thickness of the flow and consisting of a more irregular jointing pattern where columnar joints, if present, are less distinct than in the colonnade; and
- (3) A vesicular and rubbly flow top making up 10 to 30 percent of the flow unit.

FIGURE 4

SCHEMATIC OF WELL RSH-1

Most flows also have a thin broken zone a few inches thick at the base. Some flow tops, particularly in the Saddle Mountains Formation, are capped by a thin sedimentary layer. Cooling joints are frequently filled with secondary minerals such as zeolites, amorphous iron-rich silicates and ferro-magnesium clays.⁽²¹⁾

Whole rock chemical analyses are needed to properly identify most stratigraphic locations and basalt flows. Downhole geophysical information alone is not sufficient. Since individual flow identification is not available for all the basalts penetrated by RSH-1, more general phrases than interflow or columnar basalt are used within this report. "Low-density zone, basalt or section" are used to refer to those intervals having low bulk densities (~ 2.3 to 2.6 grams per cubic centimeter), long acoustic transit times and frequent borehole breakouts. These zones normally correspond to flow tops or interflows. In like manner, the phrase "high-density zone, basalt or section" or "denser basalts" is used to denote those intervals having high bulk densities (~ 2.7 to 2.9 grams per cubic centimeter), short acoustic transit times and few, if any, borehole breakouts. Such intervals normally represent the colonnade and entablature portion of a basalt flow. The above density ranges have been determined for Columbia River Basalt using a downhole gravity meter survey.⁽²²⁾

GEOPHYSICAL LOGGING

INTRODUCTION

Beginning April 13, 1977, the Birdwell Division of Raytheon Company, Tulsa, Oklahoma, conducted caliper, three-dimensional velocity and Seisviewer geophysical logging through the interval 1,000 feet to 2,860 feet below ground level. Logging was completed April 21, 1977. This work supplemented information obtained from earlier logging by other researchers.⁽¹⁾ Reproductions of these new logs are contained in Appendix A.

In addition to the above three logs, a downhole camera was used to take oriented photographs of the borehole; however, poor photographs were obtained because of the water's turbidity. The results were of no interpretive value and are not included in this report.

Variations in log responses reflect minor changes in borehole width and in the rock's fracturing pattern. The three logs mentioned above can provide information as to:

- (1) Individual basalt flow thicknesses;
- (2) Variations in the thicknesses of high- and low-density basalt zones;
- (3) Areas of drilling mud cake buildup; and
- (4) Borehole size changes.

These data are important in the interpretation of the response of the rock to fluid injection and in minimizing or eliminating water leakage around the inflatable packers used during drillstem testing.

The geophysical log responses reflect only those rock characteristics within the immediate vicinity of the borehole. These features may or may not be representative of the entire rock mass. However, since similar log responses have been observed in other boreholes on the Hanford Site, it is assumed that these responses are generally representative of the formations penetrated.

GENERAL DESCRIPTION OF GEOPHYSICAL LOGS

Caliper Log

The caliper log gives a trace of the diameter and geometry of the borehole. This trace delineates breakouts, particularly in high-porosity zones where vesicular and rubble rock exist, areas of possible mud cake buildup and other information such as roundness and smoothness of the borehole walls. This log assists in identifying those downhole intervals of smooth gauge hole in which packers may be set with a degree of confidence against leakage.

The caliper device used was a Birdwell Model CA6. This tool has six arms which operate in pairs. Three traces which represent the arms opposite each other are shown on the caliper log contained in Appendix A. Increased borehole diameters are shown as a trace flexure toward the right side. The fourth trace is a computed average of the three paired traces. The arms are capable of detecting one-quarter-of-an-inch variation in the borehole size. The arms extend and retract as they "feel" the face of the borehole and an electrical signal is transmitted to the surface where it is converted to a trace on the chart paper.

Three-Dimensional Velocity Log

The three-dimensional velocity log was used to detect discontinuities within the basalt flows. These changes may result from variations in the intensity of jointing or in the occurrence of vesicles. This log is sometimes capable of detecting jointing variations within the dense columnar portion of a basalt flow. Such fine detail is not normally revealed using other geophysical tools. The tool consists of a series of acoustic signal transmitters and receivers which measure the transit time for specific acoustic waves to travel through the surrounding rock mass.

For use in RSH-1, the transmitting and receiving transducers were run using both 3-foot and 6-foot spacings. The 6-foot spacing run is contained in Appendix A. A signal was then pulsed at the rate of 20 cycles per second. The pressure waves received were converted into electrical signals and transmitted to the surface recording equipment.

The acoustic signals received consisted of a series of alternating voltages which varied with time. These voltages are converted to a light signal of varying intensity. This light is photographed as a horizontal line. The black and dark gray lines represent high positive voltages, the white tones high negative voltages and the lighter gray tones intermediate values.⁽²³⁾ Successively exposed lines are stacked one atop the other, as shown on the three-dimensional velocity log in Appendix A. Because the lines have a measurable thickness and successive signals are recorded approximately every inch of borehole depth, the light and dark strips produce continuous longitudinal stripes. Variations in the porosity or fracture intensity of a rock formation are shown as rapid shifts in the acoustic travel times. Most of the leftward shifts shown on the three-dimensional velocity log result from long acoustic transit times across low-density (high-porosity) vesicular and rubble zones. Those downhole intervals showing evenly spaced dark and light bands represent the denser portions (entablature and colonnade) of a basalt flow.

Seisviewer

This geophysical tool produces an acoustic picture of the borehole wall useful for identifying and viewing joints, vugs, washouts and areas of mud cake buildup. The unit consists of a scanner-transducer and a

flux gate magnetometer. A transducer in a rotating scanner emits a pulsed acoustic signal which travels through the borehole fluid and reflects back to a receiving transducer. The resultant image is transmitted to the surface where it is photographed from an oscilloscope display. The image is formed from a series of horizontal lines composed of closely spaced dots of varying intensity. The amount of energy reflected back is a function of the physical characteristics of the borehole wall. Irregularities reduce the strength of the signals displayed. The weak (low-amplitude) signals appear as dark areas and the strong (high-amplitude) signals are represented by a light-colored area. Gray spots are intermediate values. Because of the high density of dots making up the final image, the Seisviewer log can delineate very small features such as individual joints and vesicles.

The magnetometer in the tool permits the acoustic signal to start only when the transducer is pointed toward magnetic north (remanent magnetism in the basalt may interfere with tool orientation). This allows the entire borehole wall to be scanned, resulting in a direct and descriptive reproduction of the borehole as if it were sliced along a single line and opened flat.

Reproductions of oriented and non-oriented Seisviewer logs are contained in Appendix A.

Downhole Camera

The borehole camera contained a 16-millimeter film magazine and a high-intensity light source. Pictures were taken using a wide-angle lens pointed down the well. A magnetic compass mounted below the lens oriented each picture.

High-resolution photography is not possible unless the borehole is full of very clear water. The photographs taken in RSH-1 were of poor quality because the borehole fluid was discolored with suspended matter.

INTERPRETATION

Geophysical logs were examined specifically for:

- (1) Identifying any variability in low- and high-density zone thicknesses;
- (2) Locating specific intervals for setting inflatable packers; and
- (3) Detecting any hole deterioration that had occurred since RSH-1 was logged 10 years earlier.

In addition, the logs supplied supplemental data not acquired in a previous study.⁽¹⁾

Ninety-two basalt flows and 89 interflow zones lying between the depths of 1,000 feet and 10,000 feet were identified from studies reported in Reference 1. The researchers hypothesized that the Columbia River Basalt Group terminated at about the 5,000-foot depth in RSH-1; below this depth, andesitic rocks were said to exist.

The gamma-gamma log⁽¹⁾ was re-examined to identify the major low- and high-density zones present within the Columbia River Basalt Group. This log is well suited for delineating lower density flow tops from the higher density basalt columns found in the entablature and colonnade portion of a flow. The specific intent of the re-examination was to determine if any discernible variation existed in the thicknesses of these individual density zones. The zero or base-line measurement point for the log was the top of the 13-1/2-foot boom used to lower the geophysical equipment into the hole. Since all geophysical logs conducted for this study and reported in Appendix A used ground level as the zero datum, comparable depths will differ by 13-1/2 feet between the two logging suites.

Figures 5 and 6 are plots of the thickness of low- and high-density zones, respectively, as a function of depth through the Columbia River Basalt Group exposed in RSH-1. Geophysical log responses were available opposite the Wanapum and Grande Ronde formations. The Saddle Mountains Formation was not logged. To eliminate the influence of hole breakouts and of small nondescript logging responses, only intraflow zones greater than 10 feet thick were plotted.

Within the 1,070 feet of Wanapum Formation logged, the low- and high-density basalt zones are generally less than 40 feet thick. The notable exceptions are 2 thick dense sections lying 740 to 870 and 1,440 to 1,590 feet below ground level, respectively (Figure 6). Both Figures 5 and 6 show only small variations in the thickness of low- and high-density zones within the Wanapum Formation.

The remaining $\pm 3,300$ feet of the Columbia River Basalt Group lie within the Grande Ronde Formation. Here, a much wider distribution of high-density zone thicknesses occurs compared to those of lower density. These distributions are shown in Figures 5 and 6 and as histograms in

V7812-1.3

FIGURE 5

THICKNESS OF LOW-DENSITY ZONES WITHIN THE COLUMBIA RIVER BASALT GROUP PENETRATED BY WELL RSH-1

COLUMBIA RIVER BASALT GROUP

FIGURE 6

THICKNESS OF HIGH-DENSITY ZONES WITHIN THE COLUMBIA RIVER BASALT GROUP PENETRATED BY WELL RSH-1

Figures 7 and 8. These last two figures give the distribution of low- and high-density zone thicknesses as divided into 25-foot thick slabs. The first slab begins at a thickness of 11 feet because, as noted earlier, all intervals less than 10 feet thick were omitted from consideration.

Figure 7 reveals that 85 percent of the Grande Ronde low-density zones (28 of 33 points) are less than 50 feet thick. This compares to only 55 percent of equivalently thick dense basalt in Figure 8. The remaining 15 percent of the low-density zones in Figure 7 are 51 to 100 feet thick. The remaining 45 percent of the high-density basalt, however, varies in thickness from 51 to 230 feet. Of particular significance are 5 dense sections greater than 100 feet thick (Figure 8). These lie between the depths of 2,675-2,795, 3,270-3,390, 3,535-3,740, 3,910-4,140 and 4,650-4,760 feet (Figure 6). The uppermost of these 5 intervals corresponds to a section called the Umtanum basalt unit. Drillstem tests were later performed across this unit.

Only one low-density zone making up part of the Grande Ronde Formation is 100 or more feet thick. This zone includes the Vantage Sandstone of the Ellensburg Formation and forms the contact between the Wanapum and Grande Ronde formations. It is 1,670 to 1,770 feet below ground level. Below this, 4 other low-density zones are 51 to 99 feet thick.

Figures 5 and 6 reveal no discernible variation or specific trends in the thickening or thinning of either the low- or high-density zones with increased depth through the Grande Ronde Formation. What is evident, however, is a much wider distribution in the thicknesses of the denser basalts compared to those of low density; this is quite obvious in Figures 7 and 8.

Periodic thickness changes of the low- and high-density zones appear in Figures 5 and 6. Figure 9 was drafted to more closely examine this phenomenon. Each 200-foot interval of the gamma-gamma log⁽¹⁾ was divided into its contributing amount of low- and high-density basalt. The results were then plotted as a function of depth (of course, the two traces are mirror images); notice the rhythmic pattern to the thicknesses of the denser basalts. For example, the maximum thicknesses of the denser basalts are centered at the depths of 900, 1,500, 2,100, 2,700

V7812-1.7

FIGURE 7

HISTOGRAM SHOWING THE FREQUENCY OF LOW-DENSITY ZONE
THICKNESSES WITHIN THE GRANDE RONDE FORMATION

FIGURE 8

HISTOGRAM SHOWING THE FREQUENCY OF HIGH-DENSITY ZONE THICKNESSES WITHIN THE GRANDE RONDE FORMATION

V7812-1.6

V7812-1.5

FIGURE 9

VARIATION OF ZONE DENSITY THICKNESSES WITHIN THE COLUMBIA RIVER BASALT GROUP

3,300, 3,900 and 4,700 feet. Except for the last footage, each of these peaks is separated by about 600 vertical feet; thinner slabs would show some pattern variation. Thus, an apparent episodic physical thickening and thinning of flows occurred at the RSH-1 site. It was reported that below the depth of 5,000 feet individual basalt flows and interflow zones thickened and their geophysical log responses became more erratic.⁽¹⁾ This evidence suggests that the basalt or basaltic-like rock below 5,000 feet has had a distinct petrogenetic origin compared to the upper rock section now assigned to the Columbia River Basalt Group.

The second task of downhole geophysics was to identify specific horizons for later hydrologic testing. The search centered on the Grande Ronde Formation above the cement plug lying at 2,860 feet.

The Seisviewer and three-dimensional velocity logs were run across the 1,000- to 2,860-foot depths. The caliper log trace was taken from ground level to the 2,860-foot depth (reproductions of these logs are contained in Appendix A; refer to Figure 4 when identifying specific formations). These logs indicate RSH-1 penetrates about 25 basalt flows between the depths of 600 and 2,860 feet. Individual flow thicknesses varied from a few tens of feet to 250 feet. The exact number of flows drilled cannot be identified solely upon geophysical log responses; trace element chemistry must be performed on actual rock samples.

The low-density zones consisting of vesicular or rubbly basalt are characterized by high porosities, long acoustic transit times and frequent borehole breakouts. The high-density sections of columnar basalt have low porosities, short sonic transit times and generally smooth borehole walls.

The Umtanum unit lying between 2,615 and 2,780 feet is the thickest single basalt flow within the Grande Ronde Formation above the aforementioned cement plug. Figure 10 shows the three-dimensional velocity and caliper logs across this zone. These traces are extracted from the geophysical logs contained in Appendix A. Table I gives the depths to the specific basalt zones shown in Figure 10 which were later hydrologically tested.

As shown in Figure 10, low-density zones are characterized by long acoustic transit times and 1- to 2-inch rock breakouts. Two of the zones

FIGURE 10

GEOPHYSICAL LOG TRACES ACROSS THE INTERVAL
2,600 TO 2,860 FEET BELOW GROUND LEVEL

TABLE I

DEPTHS TO SPECIFIC BASALT INTERVALS LATER HYDROLOGICALLY TESTED

<u>DEPTH BELOW GROUND LEVEL (FEET)</u>	<u>BASALT DENSITY</u>
2,615-2,665	Low*
2,665-2,780	High**
2,780-2,800	Low
2,800-2,825	High
2,825-2,850	Low
2,860-Cement Plug	High

*Low-density (~2.3-2.6 grams per cubic centimeter).

**High-density (~2.7-2.9 grams per cubic centimeter).

give interesting velocity responses. The vesicularity of the zone between 2,615 and 2,665 feet appears to decrease with depth as the basalt columns are approached. This feature is typically seen in basalt core samples. At 2,640 feet, the acoustic transit time decreases rapidly until denser basalt is reached at 2,665 feet. Less noticeable is the low-density zone lying between 2,780-2,800 feet. Only a slight increase in the acoustic transit time is evident, compared to the above 2 sections; this indicates a zone marked by less vesicularity and higher bulk density. The evenly spaced light and dark strips across the remaining portions of Figure 10 show areas of uniform acoustic transit times. These are characteristic of the dense columnar sections of a basalt flow.

The caliper log in Figure 10 indicates a clean borehole with no apparent mud cake buildup. A comparison between this caliper log and one run 10 years earlier⁽¹⁾ shows no apparent hole degradation.

DRILLSTEM TESTING

INTRODUCTION

A drillstem test is an analysis technique for evaluating the pressure response of a rock stratum to fluid injection or withdrawal. The results yield information about the transmissivity, permeability and other properties of the formation. The test begins by lowering a package of "tools" into the borehole at the end of a tubing string. The tools consist of packers, pressure recorders, spacing pipe and mechanical locking devices (Figure 11). The packer is made of expandable rubber which is inflated to seal off and isolate the specific formation zones tested. By opening and closing various tool ports, the formation's fluid pressure is relieved by allowing fluid to flow into the drill pipe. For an injection test, the port openings allow fluid pressure to be applied against the formation. The recorders show the initial pressure buildup and then its decay into the formation. Withdrawal tests result in pressure release from the formation. For additional information covering drillstem testing equipment and procedures, see Reference 24.

During the drillstem test, pressure records are normally obtained from three pressure recorders in the borehole. Each recorder monitors a separate borehole interval.

V7812-1.10

FIGURE 11

GENERALIZED DIAGRAM OF DRILLSTEM EQUIPMENT

Figure 12 shows a typical pressure response recorded for a drillstem test during a single flow period. This response typifies the sequence of operations from tool installation to retrieval. Pressure increases from bottom to top and time increases from left to right. Beginning at point A, the pressure increases as the equipment is lowered into the borehole. The vibrations from A to B (and also F to G) represent movements of the recorder's stylus as the tools are lowered and indicate the stylus is free and responding to pressure changes. The horizontal line at B gives the initial fluid pressure when the packer assembly is positioned opposite the desired rock formation. At C, the packers have been set and the test valve opened. Pressure drops as the fluid pressure within the tool equalizes with the formation pressure. Line C-D gives the initial flow period. At D, the test valve is closed and the formation pressure is allowed to freely build up to its hydrostatic pressure. Line D-E is the shut-in period for the test. This pressure buildup provides data about the hydrologic properties of the rocks tested. The drill pipe is raised and rotated at E, unloading the hydrostatic pressure that had developed across the packed-off formation. The final hydrostatic pressure is read at F and, from F to G, the tools are being raised from the borehole.

GENERAL THEORY

The calculation of formation characteristics from drillstem test data is based upon the simplified equations for liquid systems.⁽²⁵⁾ The following assumptions are made concerning the formations tested and their entrained fluids:

- (1) The flow obeys Darcy's law and its pattern is radial in influence;
- (2) The reservoir is homogeneous, isotropic, horizontal, uniformly thick and has infinite areal extent;
- (3) The production or injection rate is constant; and
- (4) The compressibility and absolute viscosity of the entrained fluid are reasonably constant over the working range of pressures and temperatures.

Any variation from these assumptions will cause a deviation from an otherwise straight-line plot of the borehole pressure versus the time

V7812-1.9

FIGURE 12

DRILLSTEM PRESSURE RESPONSE FOR SINGLE FLOW PERIOD

ratio $(t + \Delta t) / \Delta t$ as plotted on semi-logarithmic paper (t equals time of production or injection rate and Δt is the shut-in period).

A number of papers have been written discussing the interpretation of pressure buildup and decay curves. These pressure curves are read in time segments (t) and at their corresponding borehole pressures. These data are then plotted on semi-logarithmic paper in pounds per square inch versus the log of $(t + \Delta t) / \Delta t$.⁽²⁶⁾ The slope (m) of the buildup curve is found as the difference of pressure over one log cycle. Basically, the data interpretation consists of calculating the fluid production rate by computing the number of oil field barrels per day production using the pressure changes that take place during drill pipe fill-up.

The transmissivity (kh) is an index of the effective formation permeability and is calculated from the equation:⁽²⁵⁾

$$kh = 162.6 \frac{Q}{m} \quad (1)$$

where

k = permeability (millidarcy)

h = formation thickness (feet)

Q = production rate (barrels per day)

m = slope across one cycle of pressure buildup curve.

The 162.6 converts oil field units (barrels per day) into units of millidarcy feet. Permeability (k) in millidarcies can then be calculated using $k = kh/h$. Hydraulic conductivity (K) is next determined by the equation:

$$K = \frac{k \rho g}{\mu} \quad (2)$$

where

k = permeability (square centimeters)

ρ = density of water (grams per cubic centimeter)

g = acceleration of gravity (centimeters per square second)

μ = fluid viscosity (grams per centimeter second).

Other hydrologic properties can be calculated from the pressure buildup curves. Among these is the approximate radius of influence, which is a reasonable indication of the distance from the borehole that the formation was stressed during the test. Generally, the greater the formation's permeability and the lower its effective porosity, the larger will be the radius of influence. This approximation is derived from the permeability and the total time the well has flowed or been shut-in. A flow barrier within this radius will be reflected as a change in slope of the pressure response curve.

Several equations are available for estimating a test's radius of influence (r_i).⁽²⁷⁻³⁰⁾ The equation used in this report is modified after Reference 27 and is:

$$r_i = \sqrt{\frac{4ktB}{\theta\mu}} \quad (3)$$

where

k = permeability (square centimeters)

t = test duration (seconds)

θ = porosity (dimensionless)

μ = fluid viscosity (1 centipoise)

B = bulk modulus of elasticity for water (6.9×10^4 gram/centimeter-second square).

The skin factor is also calculated from pressure buildup curves. This factor is an index for examining the pressure effect of a zone of different permeability immediately adjacent to the borehole. This alteration of near-field permeability (the skin) commonly results from pluggage of rock pore space by drilling fluids. Pressure tests conducted across such a zone would show artificially lower or higher permeability values depending upon the permeability of the host rock.

The skin factor has been quantitatively defined as:⁽³¹⁾

$$s = \frac{\Delta P(\text{skin})}{Q\mu/2\pi kh} \quad (4)$$

where

ΔP = pressure drop across skin (feet per log cycle)

s = skin factor (dimensionless)

Q = production (barrels per day)

μ = viscosity (1 centipoise)

kh = transmissivity (millidarcy feet).

To calculate s , it is necessary to measure the well pressure both before and after the test. The radius (r_s), the skin zone around the well and the permeability (k_s) in this zone are related to the skin factor as shown by the following equation:⁽³²⁾

$$s = \left(\frac{k}{k_s} - 1 \right) \ln \frac{r_s}{r_w} \quad (5)$$

where

r_s = radius of skin (feet)

r_w = well radius (feet).

If the permeability in the skin zone (k_s) is less than the rest of the rock formation, s will be positive. If the permeabilities are equal ($k = k_s$), the skin factor is zero. Finally, if the skin permeability is greater than that in the formation, s will be negative.

Data evaluation begins by visually examining the pressure changes shown on the recorder charts. The charts are examined first to assure the packers have properly sealed and then to verify the pressure changes during testing. Typical pressure chart configurations for successful single-flow period drillstem tests and several common types of failures are found in Reference 33. Pressure charts were carefully inspected after each test to verify proper tool operation and general rock/fluid responses. The pressure variation shown on the recorder charts depends upon the productivity of the formations tested. For the ranges of low-permeability tested, the recorder charts showed relatively small pressure changes.

WORK DESCRIPTION

Table II outlines the number and type of drillstem tests performed,

TABLE II

LISTING OF ALL DRILLSTEM TESTS CONDUCTED

<u>TEST PHASE</u>	<u>TEST</u>	<u>DATES(s)</u>	<u>TYPE</u>	<u>DEPTH (FEET)</u>	<u>BASALT DENSITY</u>
1	1-1	4/27	Production	2,780-2,820	Low*
	1-2	4/27-28	Production	2,825-2,860	Low
	1-3	4/29-5/2	Production	2,700-2,770	High**
	1-4	5/2	Production	2,770-2,860	Two low-density zones
	1-5	5/4	Production	2,610-2,690	Low
	1-6	5/5-5/9	Injection	2,740-2,770	High
	1-7	5/10-5/11	Production	1,650-1,780	Low
	1-8	5/11	Production	1,780-2,860	Numerous low- and high-density zones
2	2-1	9/30-10/2	Injection	2,780-2,820	Low
	2-2	10/3-10/5	Injection	2,717-2,739	High
	2-3	10/6-10/8	Injection	2,622-2,676	Low

*Low-density (~2.3-2.6 grams per cubic centimeter).

**High-density (~2.7-2.9 grams per cubic centimeter).

testing schedule and depths, plus the physical character of the basalts tested. Testing was completed in two phases; the first in April and May 1977, and the second between September and October of the same year. Emphasis was placed on determining the hydraulic conductivities for selected low- and high-density basalt zones. Additional information was also acquired on borehole skin effects and the radius of influence of the test. All the original drillstem testing data are given in Appendix B.

As shown in Table II, eight tests were carried out during Phase 1. Of these, four tests (1-1, 1-2, 1-3, and 1-6) produced a measurable pressure response later used for hydrologic analysis. Three of the remaining four tests showed only slight or no pressure change; they were:

Test 1-5 Maximum pressure change over testing time was only 20 pounds per square inch; the rock formation was too tight for adequate interpretation of pressure curve;

Test 1-7 A production test to observe if any pressure responses would occur above and below the interflow separating the Wanapum and Grande Ronde formations; no pressure changes were noted over the test period;

Test 1-8 Production test was to monitor any pressure response occurring above the 1,763-foot depth (mostly Wanapum Formation) resulting from swabbing a 1,070-foot interval of Grande Ronde Formation; no pressure change noted in Wanapum Formation.

The tools did not seat properly during Test 1-4; no usable information was obtainable.

Three injection tests (2-1, 2-2 and 2-3) were conducted during Phase 2; each supplied excellent information. The specific zones were selected from information gained from the Phase 1 testing.

As noted in Table II, both production and injection tests were conducted during the two work phases. For production testing, the borehole was stressed by pumping or swabbing out water, and the downhole pressure changes were monitored as hydrostatic conditions returned. Injection testing was performed by subjecting the formation to pressures greater than hydrostatic. This was accomplished by injecting water through the drill pipe and into the portion of the formation isolated by packers. The fluid pressure response of the rock was monitored as it returned to hydrostatic conditions.

All tests conducted in RSH-1 were run for times ranging from a few hours to 48 hours. The longer intervals furnished more data points

on which to base interpretations. Even over the longer periods, some tests did not reach static conditions making it necessary to extrapolate fluid pressures back to the static levels.

An electric water level indicator was used during several tests to provide additional assurance that the downhole pressure recorders were giving reliable data. This water level indicator was used to monitor the declining fluid level in the drill pipe. The data comparisons were close between these measurements and those from the pressure recorders. The electric tape measurements are contained in Appendix B immediately following the pressure recorder data. These two sources of information provided for a narrow spread of calculated permeability values.

INTERPRETATION

Hydraulic Conductivity

Calculations of hydraulic conductivity and skin factor are listed in Table III for seven drillstem tests completed within the Grande Ronde Formation. The downhole position of each test is shown in Figure 13 opposite a three-dimensional velocity log trace. Four tests were conducted across vesicular and rubbly low-density zones (Tests 1-1, 1-2, 2-1 and 2-3), while the remaining three straddled sections of denser columnar basalt. Two tests (1-1 and 2-1) were completed across the same rock interval, but the first was a production test and the second an injection test. Packer spacing for all tests varied between 22 and 70 feet.

The techniques used to calculate hydraulic conductivity and the skin factor were discussed earlier. An excellent review of these techniques is detailed in Reference 26.

Hydraulic conductivities of the low- and high-density zones differed by only 2 orders of magnitude, although, as will be noted below, some of this variation may result from using two different testing techniques. Values across the low-density zones ranged from 1.7×10^{-7} to 3.8×10^{-9} centimeters per second and those for the denser columnar basalts between 1.1×10^{-8} and 4.7×10^{-9} centimeters per second. Except for Test 1-1, there was no discernible difference between the hydraulic conductivities of the low- and high-density zones. This similarity appears to indicate that the individual vesicles and fractures within the low-density zones are not interconnected. When stressed, the basalt

TABLE III

VALUES OF HYDRAULIC CONDUCTIVITY AND SKIN FACTOR

<u>TEST PHASE</u>	<u>TEST NUMBER</u>	<u>TEST TYPE</u>	<u>TEST INTERVAL (FEET)</u>	<u>BASALT DENSITY</u>	<u>HYDRAULIC CONDUCTIVITY (CENTIMETERS PER SECOND)</u>	<u>SKIN FACTOR</u>
1	1-1	Production	2,780-2,820	Low*	1.7×10^{-7} ***	-4
	1-2	Production	2,825-2,860	Low	$3.0 \times 10^{-8} - 3.5 \times 10^{-8}$	-4
	1-3	Production	2,700-2,770	High**	$4.7 \times 10^{-9} - 6.1 \times 10^{-9}$	-3
	1-6	Injection	2,740-2,770	High	$1.1 \times 10^{-8} - 1.4 \times 10^{-8}$	-1
2	2-1	Injection	2,780-2,820	Low	$7.7 \times 10^{-9} - 8.9 \times 10^{-9}$	-2
	2-2	Injection	2,717-2,739	High	1.5×10^{-8} ***	-3
	2-3	Injection	2,622-2,676	Low	$3.8 \times 10^{-9} - 5.8 \times 10^{-9}$	-2

*Low-density (~2.3-2.6 grams per cubic centimeter).

**High-density (~2.7-2.9 grams per cubic centimeter).

***Identical values were calculated using recorder and electric water level indicator measurements.

FIGURE 13

DOWNHOLE POSITION OF SEVEN DRILLSTEM TESTS

responded as a tight rock mass similar to the response of a zone of high-density columnar basalt.

Tests 1-1 and 2-1 were conducted across the same downhole interval; the only difference between the two being the first was a production test and the second an injection test. The calculated hydraulic conductivities differ by over one order of magnitude. This same range of difference is observed in comparing the results of production tests (1-3 to 2-2 and 1-6). This spread of data appears inherent when comparing results using the two testing methods.

Five drillstem tests were earlier performed⁽¹⁾ across selected low-density zones within the Columbia River Basalt Group. The reported hydraulic conductivities were 1.7×10^{-5} , 7.7×10^{-6} , 1.9×10^{-7} (two tests) and 9.7×10^{-8} centimeters per second. The highest of these values was qualified as a poor test.⁽¹⁾ The 9.7×10^{-8} centimeters per second value was calculated for the basalt section straddled between the depths of 2,614 to 2,690 feet. This crossed the same interval evaluated in Test 2-3 (Table III). Both values agree within one order of magnitude and indicate a very tight rock mass.

Skin Factor

The negative values reported in Table III reveal that the basalts immediately adjacent to the borehole are slightly more permeable than the overall rock stratum. Because of the negative skin, less of a pressure drop (ΔP) is obtained across the test zone proportional to the rate of fluid production or injection (Q). In tests where the radius of influence is small, a large negative skin (≥ 7) reveals that the permeability measured is probably greater than the undisturbed rock permeability. However, the skin values reported in Table III show:

- (1) There was no interfering mud cake across the test horizons which would have produced a positive skin; and
- (2) The reported hydraulic conductivity values are probably characteristic and conservative for the rocks tested.

Static Water Pressures

Except for a single cement plug, RSH-1 has been hydraulically open to ground water cross-flow since its completion in 1958. During this time, average or composite water pressures have been establishing themselves in the well. Those interflows contributing water (of higher pressure) would

presently show lower pressures than originally found before drilling. The opposite would be true for the interflows accepting ground water from zones of higher potential. For this reason, it was not possible to obtain meaningful static water pressures during the short-term drillstem tests.

Radius of Influence

The equation⁽²⁸⁾ used to interpret the radius of influence for the seven drillstem tests given in Table III is explained in the section entitled "General Theory;" results are listed in Table IV. In each instance, the radius of influence was calculated as less than one centimeter from the borehole. It is the authors' opinion that these values are minimum estimates and that the actual radius of influence probably extends on the order of 100 centimeters from the borehole. Because of the variability in rock properties over short distances, these results should be considered as only an order of magnitude estimate. Generally, the smaller the radius of influence, the lower will be the permeability and effective porosity of the rock. The small values given in Table IV indicate that the basalts were hydraulically tight permitting only limited rock volumes to be stressed. It can then be assumed the test results are characteristic of the basalt rock within the immediate vicinity of the borehole.

CONCLUSIONS

Several conclusions can be drawn from the geophysical logging and hydrologic testing of Well RSH-1.

- (1) In comparison with the Wanapum Formation, the Grande Ronde Formation contains a greater percentage of thick high-density basalt zones. Ninety-two percent of the denser basalts within the Wanapum are less than 50 feet thick, compared to 55 percent in the Grande Ronde.
- (2) Low-density zone thicknesses are not dependent upon the thicknesses of the underlying denser basalts. This suggests that the thickness of a basalt interflow bears no direct relation to the thickness of the associated columnar basalt.
- (3) Calculations of hydraulic conductivity for both low- and high-density basalts give very small values. Values in the lower density zones ranged between 1.7×10^{-7} and 3.8×10^{-9} centimeters per second. Values for the denser basalts were between 1.1×10^{-8} and 4.7×10^{-9} centimeters per second.

TABLE IV

VALUES FOR RADIUS OF INFLUENCE

<u>TEST PHASE</u>	<u>TEST NUMBER</u>	<u>PERMEABILITY (SQUARE CENTIMETERS)*</u>	<u>TIME (SECONDS)</u>	<u>RADIUS OF INFLUENCE (CENTIMETERS)**</u>
1	1-1	1.7×10^{-12}	8.4×10^3	0.6
	1-2	3.3×10^{-13}	5.46×10^4	0.7
	1-3	5.5×10^{-14}	1.86×10^5	0.5
	1-6	1.3×10^{-13}	1.41×10^5	0.7
2	2-1	8.5×10^{-14}	1.30×10^5	0.6
	2-2	1.5×10^{-13}	1.48×10^5	0.8
	2-3	4.9×10^{-14}	1.48×10^5	0.4

*Average permeability from Table III.

**1 percent porosity assumed.

- (4) Skin factors revealed the drillstem tests were conducted across clean rock zones having no detectable mud cake buildup.
- (5) The radius of influence for each drillstem test was at a maximum of a few feet from the borehole.
- (6) Because of low quantities of water found in the basalt, injection testing proved more reliable than production testing.

ACKNOWLEDGMENTS

The authors acknowledge the cooperation of Drs. L. S. Leonhart and C. W. Myers and Messrs. R. L. Biggerstaff and D. J. Brown who reviewed this report. Appreciation goes to Mr. S. C. Anama of Lynes Inc., who conducted the drillstem tests with the report's co-author, Mr. P. A. Eddy. Special recognition is given to Mr. Eddy for his permeability calculations contained in this report.

REFERENCES

1. J. R. Raymond and D. D. Tillson, Evaluation of a Thick Basalt Sequence in South-Central Washington, BNWL-776, Battelle, Pacific Northwest Laboratories, Richland, Washington (1968).
2. A. C. Waters, "Volcanic Rocks and the Tectonic Cycle," Geological Society of America Special Paper 62, 703-722 (1955).
3. J. Gray and L. R. Kittleman, "Geochronometry of the Columbia River Basalt and Associated Floras of Eastern Washington and Western Idaho," American Journal of Science, 265 (4), 257-291 (1967).
4. J. F. Evernden and G. T. James, "Potassium Argon Dates and the Tertiary Floras of North America," American Journal of Science, 262 (8), 945-974 (1964).
5. D. A. Holmgren, "K/Ar Dates and Paleomagnetism of the Type Yakima Basalt, Central Washington," in Proceedings of the Second Columbia River Basalt Symposium, Cheney, Washington, March 1969, Eastern Washington State College Press, Cheney, Washington (1970).
6. N. D. Watkins, "Paleomagnetism of the Columbia Plateau," Journal of Geophysical Research, 70 (6), 1379-1406 (1965).
7. D. A. Swanson and T. L. Wright, "Bedrock Geology of the Northern Columbia Plateau and Adjacent Areas," in The Channeled Scabland, V. R. Baker and D. Nummendal, editors, National Aeronautics and Space Administration, Washington, D. C. (June 1978).

8. C. W. Myers, Yakima Basalt Flows Near Vantage and from Core Holes in the Pasco Basin, Washington, Ph. D. Dissertation, University of California at Santa Cruz, Santa Cruz, California (1973).
9. C. W. Myers and D. J. Brown, "Stratigraphy of the Yakima Basalt in the Pasco Basin, Washington," Geological Society of America (Cordilleran Section), 5 (1), 80 (1973).
10. D. J. Brown and R. K. Ledgerwood, "Stratigraphy and Structure of Yakima Basalt in Pasco Basin, Washington," Geologic Field Trips in Northern Oregon and Southern Washington, Oregon Department of Geology and Mineral Industries Bulletin, 77, 171-181 (1973).
11. K. R. Newman, "Palynology of Interflow Sediments from the Standard Oil Company of California Rattlesnake Hills No. 1 Well, Benton County, Washington," in Proceedings of the Second Columbia River Basalt Symposium, Cheney, Washington, March 1969, Eastern Washington State College Press, Cheney, Washington (1970).
12. D. P. Hill, "Crustal and Upper Mantle Structure of the Columbia River Plateau from Long Range Seismic Refraction Measurements," Geological Society of America Bulletin 83, 1639-1648 (1972).
13. J. H. Skehan, A Continental-Oceanic Crustal Boundary in the Pacific Northwest, AFCRL-65-904, Air Force Cambridge Research Laboratories, Office of Aerospace Research, Bedford, Massachusetts (1965).
14. E. Raisz, "The Olympic-Wallowa Lineament," American Journal of Science, 243-A, 479 (1945).
15. T. Cantwell, P. Nelson, J. Webb, and A. S. Orange, "Deep Resistivity Measurements in the Pacific Northwest," Journal of Geophysical Research, 70 (8), 1931-1937 (1965).
16. S. L. Robbins, R. J. Burt, and D. O. Gregg, "Gravity and Aeromagnetic Study of Part of the Yakima River Basin, Washington," U. S. Geological Survey Professional Paper 726-E (1975).
17. D. E. Peterson and R. E. Brown, Gravity Anomalies and Geologic Structures of the Central Part of the Columbia River Basalt Plateau, BNWL-SA-812, Battelle, Pacific Northwest Laboratories, Richland, Washington (1966).
18. W. H. Taubeneck, "An Evaluation of Tectonic Rotation in the Pacific Northwest," Journal of Geophysical Research, 71 (8), 2113-2120 (1966), and 72, 1415-1421 (1967).
19. A. C. Waters, "Basalt Magma Types and Their Tectonic Association: Pacific Northwest of the United States," American Geophysical Union Geophysical Monographs, 6, 158-170 (1962).
20. A. B. Griggs, "The Columbia River Basalt Group in the Spokane Quadrangle, Washington, Idaho, and Montana," U. S. Geological Survey Bulletin, 1413, 39 (1976).

21. R. A. Deju, P. A. Eddy, M. W. Grutzeck, and C. W. Myers, Environmental Factors Needed to Establish the Geotechnical Feasibility of Storing Radioactive Waste in Columbia River Basalt, RHO-ST-8, Rockwell Hanford Operations, Richland, Washington (September 1977).
22. Exploration Data Consultants, Inc., Fenix and Scisson, Inc., Borehole Gravity Meter Survey Report, June 15-17, 1978, October 17-19, 1978, Lakewood, Colorado
23. H. Guyod and L. E. Shane, Geophysical Well Logging, Hubert Guyod and Company, Houston, Texas (1969).
24. H. K. Van Poolen, "Status of Drill-Stem Testing Techniques and Analysis," Journal of Petroleum Technology, 333-339 (1961).
25. D. R. Horner, "Pressure Buildup in Wells," in Proceedings of the Third World Petroleum Congress, E. J. Brill, Editor, Leiden Publishing, II, 503 (1951).
26. C. S. Matthews and D. G. Russell, "Pressure Buildup and Flow Test in Wells", Monograph Volume 1 of Society of Petroleum Engineers, Storm Printing Corporation, Dallas, Texas (1967).
27. J. H. Moran, and E. E. Finklea, "Analysis of Pressure Build-up Data Obtained by the Wire Line Formation Tester," Paper SPE 177; in Proceedings of the 36th Annual Fall Meeting Society of Petroleum Engineers, Dallas, Texas, (October 1961).
28. P. J. Jones, "Draw Down Exploration, Reservoir Limit, Well and Formation Evaluation," Permian Basin Oil Recovery Conference of American Institute of Mining Engineers, Midland, Texas (April 1957).
29. W. Hurst, O. K. Hanie, and R. N. Walker, "Some Problems in Pressure Build-up," Paper SPE 145, in Proceedings of the 36th Annual Fall Meeting, Society of Petroleum Engineers, Dallas, Texas (October 1961), also "New Concept Extends Pressure Build-up Analysis," Petroleum Engineering, 34 (9), 41 (August 1962).
30. L. F. Maier, "Recent Developments in the Interpretation and Application of DST Data," Journal of Petroleum Technology, XIV (11), (November 1962).
31. A. F. Everdigen, "The Skin Effect and Its Influence on the Productive Capacity of a Well," Transactions of the American Institute of Mining Engineers, 198, 171-176 (1953).
32. M. F. Hawkins Jr., "A Note on the Skin Factor," Transactions of the American Institute of Mining Engineers, 207, 356-357 (1956).
33. W. Marshall Black, "A Review of Drill-Stem Testing Techniques and Analysis," Journal of Petroleum Technology, 21-30 (June 1956).

DISTRIBUTION

Number of
Copies

1	<u>J. F. T. AGAPITO</u>
1	<u>AMOCO</u> G. Servos
1	<u>H. G. ANDERSON</u>
1	<u>ATOMICS INTERNATIONAL</u> H. C. Weiseneck
4	<u>BATTELLE-OFFICE OF NUCLEAR WASTE ISOLATION</u> J. M. Batch R. E. Heineman M. Kahnemuyi P. F. Patchick
1	<u>BOEING COMPUTER SERVICES RICHLAND, INC.</u> R. W. Nelson
1	<u>BROOKHAVEN NATIONAL LABORATORY</u> P. W. Levy
1	<u>BROWN UNIVERSITY</u> B. Gilletti
1	<u>CALIFORNIA ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION</u> W. Irving
2	<u>CENTRAL WASHINGTON UNIVERSITY</u> Department of Geology Library
1	<u>COLORADO SCHOOL OF MINES</u> F. D. Wang
1	<u>DARTMOUTH COLLEGE</u> J. Lyons

Distribution (continued)

Number of
Copies

2	<u>EASTERN WASHINGTON UNIVERSITY</u> Department of Geology Library
1	<u>FOUNDATION SCIENCES, INC.</u> D. J. Dodds
1	<u>THE GEOLOGICAL SOCIETY OF AMERICA, INC.</u> J. C. Frye
1	<u>GEOSCIENCE RESEARCH CONSULTANTS</u> J. G. Bond
1	<u>HARVARD UNIVERSITY</u> R. Siever
2	<u>IDAHO BUREAU OF MINES AND GEOLOGY</u> M. M. Miller Library
1	<u>KANSAS STATE GEOLOGICAL SURVEY</u> W. W. Hambleton
2	<u>LAWRENCE BERKELEY LABORATORY</u> L. V. Benson P. A. Witherspoon
1	<u>LAWRENCE LIVERMORE LABORATORIES</u> L. Ramspott
1	<u>LOS ALAMOS SCIENTIFIC LABORATORY</u> M. L. Wheeler
1	<u>LYNES, INC.</u> S. C. Anama
1	<u>OREGON STATE DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES</u> J. D. Beaulieu

Distribution (continued)

Number of
Copies

10	<u>PACIFIC NORTHWEST LABORATORY</u> P. A. Eddy (5) J. R. Eliason A. M. Platt (2) R. W. Wallace Library
1	<u>THE PENNSYLVANIA STATE UNIVERSITY</u> G. J. McCarthy
1	<u>PRINCETON UNIVERSITY</u> G. Pinder
4	<u>SANDIA LABORATORIES</u> F. A. Donath O. E. Jones R. W. Lynch W. D. Weart
1	<u>SEISMOGRAPH SERVICE CORPORATION</u> Library
1	<u>SENTURION SCIENCES, INC.</u> Library
1	<u>STANFORD UNIVERSITY</u> I. Remson
1	<u>W. K. SUMMERS AND ASSOCIATES</u>
1	<u>TERRATEK</u> Library
1	<u>TEXAS A & M UNIVERSITY</u> J. Handin
1	<u>UNION OF CONCERNED SCIENTISTS</u> R. Lipschutz

Distribution (continued)

Number of
Copies

1	<u>UNITED NUCLEAR INDUSTRIES, INC.</u> G. O. Amy												
2	<u>U. S. ARMY CORPS OF ENGINEERS</u> Walla Walla District Geologist Walla Walla District Librarian												
1	<u>U. S. BUREAU OF MINES</u> J. W. Corwine												
1	<u>U. S. BUREAU OF RECLAMATION</u> D. Newmann												
1	<u>U. S. DEPARTMENT OF ENERGY-ALBUQUERQUE OPERATIONS OFFICE</u> D. T. Schueler												
1	<u>U. S. DEPARTMENT OF ENERGY-COLUMBUS PROGRAM OFFICE</u> J. Neff												
10	<u>U. S. DEPARTMENT OF ENERGY-HEADQUARTERS</u> <table border="0" style="margin-left: 40px;"> <tr> <td>R. H. Campbell</td> <td>D. B. LeClaire</td> </tr> <tr> <td>C. R. Cooley</td> <td>S. Meyers</td> </tr> <tr> <td>M. W. Frei</td> <td>R. G. Romatowski</td> </tr> <tr> <td>C. H. George</td> <td>R. Stein</td> </tr> <tr> <td>C. A. Heath</td> <td>D. L. Vieth</td> </tr> </table>	R. H. Campbell	D. B. LeClaire	C. R. Cooley	S. Meyers	M. W. Frei	R. G. Romatowski	C. H. George	R. Stein	C. A. Heath	D. L. Vieth		
R. H. Campbell	D. B. LeClaire												
C. R. Cooley	S. Meyers												
M. W. Frei	R. G. Romatowski												
C. H. George	R. Stein												
C. A. Heath	D. L. Vieth												
2	<u>U. S. DEPARTMENT OF ENERGY-NEVADA OPERATIONS OFFICE</u> D. G. Jackson R. M. Nelson												
1	<u>U. S. DEPARTMENT OF ENERGY-OAK RIDGE OPERATIONS OFFICE</u> C. A. Keller												
15	<u>U. S. DEPARTMENT OF ENERGY-RICHLAND OPERATIONS OFFICE</u> <table border="0" style="margin-left: 40px;"> <tr> <td>J. W. Anttonen</td> <td>P. G. Harris</td> </tr> <tr> <td>T. A. Bauman</td> <td>A. G. Lassila</td> </tr> <tr> <td>J. C. Cummings</td> <td>D. J. Squires (4)</td> </tr> <tr> <td>J. A. Fernandez</td> <td>F. R. Standerfer</td> </tr> <tr> <td>R. B. Goranson (2)</td> <td>M. W. Tiernan</td> </tr> <tr> <td></td> <td>P. S. Van Loan</td> </tr> </table>	J. W. Anttonen	P. G. Harris	T. A. Bauman	A. G. Lassila	J. C. Cummings	D. J. Squires (4)	J. A. Fernandez	F. R. Standerfer	R. B. Goranson (2)	M. W. Tiernan		P. S. Van Loan
J. W. Anttonen	P. G. Harris												
T. A. Bauman	A. G. Lassila												
J. C. Cummings	D. J. Squires (4)												
J. A. Fernandez	F. R. Standerfer												
R. B. Goranson (2)	M. W. Tiernan												
	P. S. Van Loan												

Distribution (continued)

Number of
Copies

1	<u>U. S. DEPARTMENT OF ENERGY-SAN FRANCISCO OPERATIONS OFFICE</u> J. S. Muhlestein
330	<u>U. S. DEPARTMENT OF ENERGY-TECHNICAL INFORMATION CENTER</u>
3	<u>U. S. ENVIRONMENTAL PROTECTION AGENCY</u> R. Kaufman G. L. Meyers J. Sceva
6	<u>U. S. GEOLOGICAL SURVEY</u> C. Collier G. D. DeBuchananne R. Schneider P. R. Stevens D. A. Swanson W. S. Twenhofel
3	<u>U. S. NUCLEAR REGULATORY COMMISSION</u> J. O. Bunting, Jr. J. C. Malaro E. P. Regnier
2	<u>UNIVERSITY OF IDAHO</u> Department of Geology Library
2	<u>UNIVERSITY OF MINNESOTA</u> C. A. Fairhurst C. M. St. John
2	<u>UNIVERSITY OF OREGON</u> G. Goles Library
2	<u>UNIVERSITY OF WASHINGTON</u> Department of Geology Library
1	<u>VANDERBILT UNIVERSITY</u> F. L. Parker

Distribution (continued)

Number of
Copies

1	<u>WASHINGTON PUBLIC POWER SUPPLY SYSTEM, INC.</u>	
	D. D. Tillson	
2	<u>WASHINGTON STATE DEPARTMENT OF ECOLOGY</u>	
	P. M. Grimstad Library	
2	<u>WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES</u>	
	V. E. Livingston Library	
1	<u>WASHINGTON STATE ENERGY FACILITY SITE EVALUATION COUNCIL</u>	
	N. D. Lewis	
2	<u>WASHINGTON STATE UNIVERSITY</u>	
	Department of Geology Library	
1	<u>A. C. WATERS</u>	
1	<u>WESTINGHOUSE ADVANCED ENERGY SYSTEMS</u>	
	T. Hakl	
1	<u>WESTINGHOUSE HANFORD COMPANY</u>	
	A. G. Blasewitz	
1	<u>WOODWARD-CLYDE CONSULTANTS</u>	
	Library	
97	<u>ROCKWELL HANFORD OPERATIONS</u>	
	H. Babad	J. E. Kinzer
	D. J. Cockeram	E. J. Kosiancic
	R. A. Deju	J. H. Roecker
	P. J. Fritch	L. Wilhelmi
	R. E. Gephart (5)	Basalt Waste Isolation Program
	R. J. Gimera	Library (75)
	R. D. Hammond	Document Control (4)
	W. F. Heine	Records Retention Centers (2)

APPENDIX A

GEOPHYSICAL LOG TRACES

← MICROSECONDS INCREASING
6 FEET SPACING

← MICROSECONDS INCREASING
6 FEET SPACING

← MICROSECONDS INCREASING —
6 FEET SPACING

← MICROSECONDS INCREASING —
6 FEET SPACING

← MICROSECONDS INCREASING —
6 FEET SPACING

2500

2600

← MICROSECONDS INCREASING —
6 FEET SPACING

2700

2800

F.R.2855

T.D.2860

INDIVIDUAL ARMS (ALL SCALES IN INCHES)

INDIVIDUAL ARMS (ALL SCALES IN INCHES)

INDIVIDUAL ARMS (ALL SCALES IN INCHES)

BIRDWELL																																																	
SEISVIEWER																																																		
COMPANY ATLANTIC RICHFIELD HANFORD COMPANY																																																		
WELL RSH #1																																																		
FIELD RATTLE SNAKE HILLS																																																		
COUNTY BENTON STATE WASHINGTON																																																		
LOCATION: 300' N & 300' WEST OF SE CORNER OF SEC. 15 TWP. 11N RGE. 24E	OTHER SERVICES 3-D CA6																																																	
PERMANENT DATUM GROUND LEVEL, ELEV. 2880 LOG MEASURED FROM G.L. 0 Ft. Above Perm. Datum DRILLING MEASURED FROM K. B.																																																		
ELEV. K.B. N.A. D.F. N.A. G.L. 2880																																																		
DATE	4-20-77																																																	
RUN NO.	ONE																																																	
TYPE LOG	SVS																																																	
DEPTH - DRILLER	2980.5																																																	
DEPTH - LOGGER	2860																																																	
BTM. LOG. INTER.																																																		
TOP LOG. INTER.																																																		
TYPE FLUID IN HOLE	WATER																																																	
SALINITY PPM CL.	N.A.																																																	
DENSITY LB./GAL.	8.3																																																	
LEVEL	1010																																																	
MAX.REC.TEMP. - °F	N.A.																																																	
OPER. RIG TIME																																																		
RECORDED BY	SCHRODER																																																	
WITNESSED BY	MR. EDDY																																																	
LOCATION	37																																																	
RUN NO.	BORE HOLE RECORD																																																	
	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%;">BIT</th> <th style="width: 20%;">FROM</th> <th style="width: 20%;">TO</th> <th style="width: 10%;">SIZE</th> <th style="width: 10%;">WGT.</th> <th style="width: 20%;">FROM</th> <th style="width: 20%;">TO</th> </tr> <tr> <td>ONE</td> <td>N.A.</td> <td>SURF</td> <td>600</td> <td>15-3/8</td> <td>N.A.</td> <td>0</td> </tr> <tr> <td></td> <td>9-7/8</td> <td>600</td> <td>T.D.</td> <td></td> <td></td> <td>600'</td> </tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </table>	BIT	FROM	TO	SIZE	WGT.	FROM	TO	ONE	N.A.	SURF	600	15-3/8	N.A.	0		9-7/8	600	T.D.			600'																												
BIT	FROM	TO	SIZE	WGT.	FROM	TO																																												
ONE	N.A.	SURF	600	15-3/8	N.A.	0																																												
	9-7/8	600	T.D.			600'																																												
	CASING RECORD																																																	

all depths in feet below ground level

NOT ORIENTED

ORIENTED

ORIENTED

APPENDIX B

DRILLSTEM TEST DATA

TEST 1-1

Phone
522-1206 Area 303

LYNES, INC.

Box 712
Sterling, Colo.

Spot	--	Csg. Size & Grade	13 3/8"
Sec.	--	Tubing Size	2 7/8" 6.5#
Twp.	--	Tool Depth	2780-2820'
Rng.	--	On Location @	--
Field	Rattle Snake Hill	Off Location @	--
County	Benton	Lynes Rep.	Stan Anama
State	Washington	Well Owners Rep.	Paul Eddy

Tool Description Treating & Testing Tool

Packer size 7 3/8" X 66"

PO# WTC-SBB-39166

Summary: Test #1

4-27-77

8:00 AM.

Filled tubing and inflated packers with 600 psig. surface pressure.

9:40 AM:

Moved tool to between position, swabbed down 1500'. Let set for 50 minutes. Continued to swab, swabbed down at 1:14 PM. Let set for 90 minutes. Ran swab to check for recovery-no recovery.

Flowing pressures in 15 minute increments on following pages.

Operator Arco Refining Co.
Attn: Paul Eddy, Box 250
Address Richland, Washington 99352

Well Name and No. RSH #1
Type Tool Treating & Testing Tool

License No. 1156

LYNES, INC.

Operator Arco Hanford Co.

Lease & No. _____

RSH #1

DST No. 1

Above Interval		
PRD Make	Kuster K-3	
No. 12985	Cap. 6100	@ 2763'
Press		Corrected
Initial Hydrostatic	A	729
Final Hydrostatic	K	722
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

Between Interval		
PRD Make	Kuster K-3	
No. 15579	Cap. 6200	@ 2792'
Press		Corrected
Initial Hydrostatic	A	872
Final Hydrostatic	K	--
Initial Flow	B	555
Final Initial Flow	C	657
Initial Shut-in	D	--
Second Initial Flow	E	170
Second Final Flow	F	267
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 1

Below Interval

PRD Make Kuster K-3
No. 15714 Cap. 6000 @ 2826'

Press		Corrected
Initial Hydrostatic	A	758
Final Hydrostatic	K	--
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

PRD Make _____
No. _____ Cap. _____ @ _____

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 1

Recorder No. 15579Initial Flow

0 min.	555	psig.
15 "	634	"
30 "	647	"
45 "	654	"
50 "	657	"

Final Flow

0 min.	170	psig.
15 "	251	"
30 "	259	"
45 "	262	"
60 "	262	"
75 "	262	"
90 "	267	"

TEST 1-2

Phone
522-1206 Area 303

LYNES, INC.

Box 712
Sterling, Colo.

Spot	--	Csg. Size & Grade	13 3/8"
Sec.	--	Tubing Size	2 7/8" 6.5#
Twp.	--	Tool Depth	2825-2860'
Rng.	--	On Location @	--
Field	Rattle Snake Hill	Off Location @	--
County	Benton	Lynes Rep.	Stan Anama
State	Washington	Well Owners Rep.	Paul Eddy

Tool Description Treating & Testing Tool

Packer size 7 3/8" X 66"

PO# WTC-SBB-39166

Summary:

Test #2

4-27-77
3:21 PM.

Filled tubing and moved tool to below position.

4:50 PM.

Swabbed down and let set for 910 minutes.

4-28-77
8:00 AM.

Ran swab to check for recovery, recovered 50 gallons of water.
Filled tubing and released packers.

Flowing pressures in 15 minute increments on following pages.

Operator Arco Hanford Co.
Attn: Paul Eddy, Box 250
Address Richland, Washington 99352

Well Name and No. RSH #1
Type Tool Treating & Testing Tool

Date 4-27-77
Ticket No. 1156

LYNES, INC.

Operator Arco Hanford Co.Lease & No.

RSH #1

DST No. 2

Above Interval		
PRD Make Kuster K-3		
No. 12985	Cap. 6100	@ 2808'
Press		Corrected
Initial Hydrostatic	A	729
Final Hydrostatic	K	722
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

Between Interval		
PRD Make Kuster K-3		
No. 15579	Cap. 6200	@ 2837'
Press		Corrected
Initial Hydrostatic	A	872
Final Hydrostatic	K	--
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 2

Below Interval

PRD Make Kuster K-3
No. 15714 Cap. 6000 @ 2866'

Press		Corrected
Initial Hydrostatic	A	758
Final Hydrostatic	K	--
Initial Flow	B	25
Final Initial Flow	C	508
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

PRD Make _____
No. _____ Cap. _____ @ _____

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 2

Recorder No. 15714

0 min.	25 psig.	465 min.	490 psig.
15 "	359 "	480 "	490 "
30 "	376 "	495 "	490 "
45 "	389 "	510 "	492 "
60 "	399 "	525 "	492 "
75 "	409 "	540 "	492 "
90 "	414 "	555 "	492 "
105 "	422 "	570 "	492 "
120 "	434 "	585 "	492 "
135 "	447 "	600 "	492 "
150 "	460 "	615 "	500 "
165 "	460 "	630 "	503 "
180 "	465 "	645 "	503 "
195 "	472 "	660 "	503 "
210 "	477 "	675 "	503 "
225 "	482 "	690 "	508 "
240 "	487 "	705 "	510 "
255 "	487 "	720 "	515 "
270 "	487 "	735 "	518 "
285 "	492 "	750 "	518 "
300 "	492 "	765 "	518 "
315 "	495 "	780 "	518 "
330 "	495 "	795 "	515 "
345 "	495 "	810 "	514 "
360 "	492 "	825 "	513 "
375 "	492 "	840 "	510 "
390 "	492 "	855 "	508 "
405 "	493 "	870 "	508 "
420 "	493 "	885 "	508 "
435 "	490 "	900 "	508 "
450 "	490 "	910 "	508 "

TEST 1-2

Water Pressures Below Packers*

<u>Time (Min)</u>	<u>PSIG</u>
0	351.1
55	407.6
60	411.5
100	445.5
230	472.9
370	479.8
595	485.0
970	505.0

*Electric tape measurement.

TEST 1-3

Phone
522-1206 Area 303

LYNES, INC.

Box 712
Sterling, Colo.

Spot	--	Csg. Size & Grade	13 3/8"
Sec.	--	Tubing Size	2 7/8" 6.5#
Twp.	--	Tool Depth	2700-2770'
Rng.	--	On Location @	--
Field	Rattle Snake Hill	Off Location @	--
County	Benton	Lynes Rep.	Stan Anama
State	Washington	Well Owners Rep.	Paul Eddy

Tool Description Treating & Testing Tool

Packer size 7 3/8" X 66"

PO# WTC-SBB-39166

Summary: Test #3

4-29-77

9:30 AM.

Packers in place, filled tubing to inflate, inflated packers with 500 psig. surface pressure.

3:51 PM.

Moved tool to between position and began swabbing. Swabbed down 2000' and let set for 10 minutes, continued swabbing. Swabbed down at 5:10 PM. Left in open position for 3770 minutes.

5-2-77

8:43 AM.

Ran swab to check recovery. Recovered 50 gallons of water. Filled tubing.

Flowing pressures in 15 minute increments on following pages.

Operator Arco Hanford Co.
Attn: Paul Eddy, Box 250,
Richland, Washington 99352

Well Name and No. RSH #1
Type Tool Treating & Testing Tool

Date 4-29-77
Ticket No. 1156

LYNES, INC.

Operator Arco Hanford Co.Lease & No. RSH #1DST No. 3

Above Interval

PRD Make Kuster K-3No. 15579 Cap. 6200 @ 2683'

Press		Corrected
Initial Hydrostatic	A	686
Final Hydrostatic	K	712
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled ToCharts indicate clock
stopped during test.

Between Interval

PRD Make Kuster K-3No. 12985 Cap. 6100 @ 2712'

Press		Corrected
Initial Hydrostatic	A	729
Final Hydrostatic	K	--
Initial Flow	B	24
Final Initial Flow	C	170
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled ToClock ran out 3107 minutes
into test.

LYNES, INC.

Operator Arco Hanford Co.Lease & No. RSH #1DST No. 3

Bottom Set 2 Test 4
Recorder N15714 48

Below Interval

PRD Make Kuster K-3
No. 15714 Cap. 6000 @ 2776'

Press		Corrected
Initial Hydrostatic	A	750
Final Hydrostatic	K	747
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

Charts indicate clock
stopped during test.

PRD Make _____
No. _____ Cap. _____ @ _____

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 3

Recorder No. 12985

0 min.	24 psig.	540 min.	97 psig.
15 "	47 "	555 "	98 "
30 "	52 "	570 "	99 "
45 "	58 "	585 "	99 "
60 "	60 "	600 "	100 "
75 "	63 "	615 "	101 "
90 "	65 "	630 "	101 "
105 "	68 "	645 "	102 "
120 "	68 "	660 "	102 "
135 "	71 "	675 "	103 "
150 "	73 "	690 "	103 "
165 "	73 "	705 "	104 "
180 "	76 "	720 "	104 "
195 "	76 "	735 "	105 "
210 "	77 "	750 "	105 "
225 "	79 "	765 "	105 "
240 "	80 "	780 "	106 "
255 "	82 "	795 "	107 "
270 "	82 "	810 "	107 "
285 "	82 "	825 "	108 "
300 "	84 "	840 "	109 "
315 "	86 "	855 "	110 "
330 "	87 "	870 "	111 "
345 "	88 "	885 "	111 "
360 "	89 "	900 "	112 "
375 "	89 "	915 "	113 "
390 "	90 "	930 "	113 "
405 "	90 "	945 "	113 "
420 "	92 "	960 "	114 "
435 "	93 "	975 "	114 "
450 "	93 "	990 "	115 "
465 "	94 "	1005 "	115 "
480 "	94 "	1020 "	116 "
495 "	95 "	1035 "	116 "
510 "	95 "	1050 "	117 "
525 "	96 "	1065 "	118 "

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 3

Recorder No. 12985

1080 min.	119 psig.	1620 min.	136 psig.
1095 "	119 "	1635 "	137 "
1110 "	119 "	1650 "	137 "
1125 "	120 "	1665 "	137 "
1140 "	120 "	1680 "	138 "
1155 "	121 "	1695 "	138 "
1170 "	121 "	1710 "	138 "
1185 "	121 "	1725 "	138 "
1200 "	122 "	1740 "	139 "
1215 "	122 "	1755 "	139 "
1230 "	123 "	1770 "	139 "
1245 "	123 "	1785 "	139 "
1260 "	124 "	1800 "	140 "
1275 "	124 "	1815 "	140 "
1290 "	125 "	1830 "	140 "
1305 "	126 "	1845 "	140 "
1320 "	126 "	1860 "	141 "
1335 "	127 "	1875 "	141 "
1350 "	127 "	1890 "	141 "
1365 "	128 "	1905 "	142 "
1380 "	128 "	1920 "	142 "
1395 "	129 "	1935 "	142 "
1410 "	129 "	1950 "	142 "
1425 "	130 "	1965 "	143 "
1440 "	131 "	1980 "	143 "
1455 "	131 "	1995 "	143 "
1470 "	132 "	2010 "	144 "
1485 "	132 "	2025 "	144 "
1500 "	133 "	2040 "	144 "
1515 "	133 "	2055 "	145 "
1530 "	134 "	2070 "	145 "
1545 "	135 "	2085 "	145 "
1560 "	135 "	2100 "	146 "
1575 "	135 "	2115 "	146 "
1590 "	136 "	2130 "	146 "
1605 "	136 "	2145 "	147 "

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 3

Recorder No. 12985

2160 min.	147 psig.	2655 min.	158 psig.
2175 "	147 "	2670 "	158 "
2190 "	148 "	2685 "	159 "
2205 "	148 "	2700 "	159 "
2220 "	148 "	2715 "	159 "
2235 "	148 "	2730 "	160 "
2250 "	149 "	2745 "	160 "
2265 "	149 "	2760 "	161 "
2280 "	149 "	2775 "	161 "
2295 "	150 "	2790 "	162 "
2310 "	150 "	2805 "	162 "
2325 "	150 "	2820 "	163 "
2340 "	151 "	2835 "	163 "
2355 "	151 "	2850 "	163 "
2370 "	151 "	2865 "	164 "
2385 "	152 "	2880 "	164 "
2400 "	152 "	2895 "	164 "
2415 "	152 "	2910 "	165 "
2430 "	153 "	2925 "	165 "
2445 "	153 "	2940 "	166 "
2460 "	153 "	2955 "	166 "
2475 "	154 "	2970 "	167 "
2490 "	154 "	2985 "	167 "
2505 "	154 "	3000 "	167 "
2520 "	155 "	3015 "	168 "
2535 "	155 "	3030 "	168 "
2550 "	155 "	3045 "	169 "
2565 "	156 "	3060 "	169 "
2580 "	156 "	3075 "	169 "
2595 "	157 "	3090 "	170 "
2610 "	157 "	3105 "	170 "
2625 "	157 "	3107 "	170 "
2640 "	158 "		

TEST 1-3

Water Pressures Between Packers*

<u>Time (Min)</u>	<u>PSIG</u>
0	14.7
60	115
180	122
270	125
1140	135
1560	150
3060	160

*Electric tape measurement.

TEST 1-4

Phone
522-1206 Area 303

LYNES, INC.

Box 712
Sterling, Colo.

Spot	--	Csg. Size & Grade	13 3/8"
Sec.	--	Tubing Size	2 7/8" 6.5#
Twp.	--	Tool Depth	2770-2860'
Rng.	--	On Location @	--
Field	Rattle Snake Hill	Off Location @	--
County	Benton	Lynes Rep.	Stan Anama
State	Washington	Well Owners Rep.	Paul Eddy

Tool Description Treating & Testing Tool

Packer size 7 3/8" X 66"

P0# WTC-SBB-39166

Summary:

Test #4

5-2-77
9:25 AM.

Moved tool to below position, began swabbing. Swabbed down at 10:07 AM. Let set open for 60 minutes. Made swab run to check for recovery. Recovered 50 gallons of water. Filled tubing, released packers.

Flowing pressures in 15 minute increments on following pages.

Operator Arco Hanford Co.
Address Attn: Paul Eddy, Box 250
Richland, Washington 99352

Well Name and No. RSH #1
Type Tool Treating & Testing Tool

Date 5-2-77
Ticket No. 1156

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 4

Above Interval

PRD Make Kuster K-3
No. 15579 Cap. 6200 @ 2683'

Press.		Corrected
Initial Hydrostatic	A	686
Final Hydrostatic	K	712
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

Charts indicate clock
stopped during test.

Between Interval

PRD Make Kuster K-3
No. 12985 Cap. 6100 @ 2712'

Press		Corrected
Initial Hydrostatic	A	729
Final Hydrostatic	K	--
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut in	J	--

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Arco Hanford Co.Lease & No. RSH #1DST No. 4

Bottom Set 2 Test 4
Recorder N15714 48

A

K

B

C

Below Interval

 PRD Make Kuster K-3
 No. 15714 Cap. 6000 @ 2776'

Press	Corrected
Initial Hydrostatic A	750
Final Hydrostatic K	747
Initial Flow B	48
Final Initial Flow C	162
Initial Shut-in D	--
Second Initial Flow E	--
Second Final Flow F	--
Second Shut-in G	--
Third Initial Flow H	--
Third Final Flow I	--
Third Shut-in J	--

 Pressure Below Bottom
 Packer Bled To

 PRD Make _____
 No. _____ Cap. _____ @ _____
 Press Corrected

Initial Hydrostatic A	
Final Hydrostatic K	
Initial Flow B	
Final Initial Flow C	
Initial Shut-in D	
Second Initial Flow E	
Second Final Flow F	
Second Shut-in G	
Third Initial Flow H	
Third Final Flow I	
Third Shut-in J	

 Pressure Below Bottom
 Packer Bled To

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 4

Recorder No. 15714

0 min.	48 psig.
15 "	114 "
30 "	131 "
45 "	146 "
60 "	162 "

TEST 1-4

Water Pressures Below Packers*

<u>Time (Min)</u>	<u>PSIG</u>
0	80
51	100
60	135
75	165
90	195
105	235

*Electric tape measurement.

TEST 1-5

Phone
522-1206 Area 303

LYNES, INC.

Box 712
Sterling, Colo.

Spot	--	Csg. Size & Grade	13 3/8"
Sec.	--	Tubing Size	2 7/8" 6.5#
Twp.	--	Tool Depth	2610-2690'
Rng.	--	On Location @	--
Field	Rattle Snake Hill	Off Location @	--
County	Benton	Lynes Rep.	Stan Anama
State	Washington	Well Owners Rep.	Paul Eddy

Tool Description Treating & Testing Tool

Packer size 7 3/8" X 66"

PO# WTC-SBB-39166

Summary: Test #5

5-4-77
2:45 PM.

Filled tubing. Inflated packers to 600 psig. surface pressure.

4:00 PM.

Moved tool to between position, began swabbing. Swabbed down at 4:52 PM. Let set for 1075 minutes.

5-4-77
8:00 AM.

Ran swab to check for recovery. No recovery. Filled tubing to equalize between packers, unable to work weight down to tools. Swabbed tubing, then refilled tubing, unable to get movement. Swabbed down and refilled tubing again. Released packers and came out of hole.

Flowing pressures in 15 minute increments on following pages.

Operator Arco Hanford Co.
Attn: Paul Eddy, Box 250
Address Richland, Washington 99352

Well Name and No. RSH #1
Type Tool Treating & Testing Tool

Date 5-3-77
Ticket No. 1156

LYNES, INC.

Operator Arco Hanford Co.Lease & No. RSH #1DST No. 5

Above Interval		
PRD Make	Kuster K-3	
No. 15714	Cap. 6000	@ 2593'
Press		Corrected
Initial Hydrostatic	A	644
Final Hydrostatic	K	672
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

Between Interval		
PRD Make	Kuster K-3	
No. 12985	Cap. 6100	@ 2622'
Press		Corrected
Initial Hydrostatic	A	668
Final Hydrostatic	K	666
Initial Flow	B	41
Final Initial Flow	C	152
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 5

Below Set 3 Test 5
Recorder # N15579
48hr.

Below Interval

PRD Make Kuster K-3
No. 15579 Cap. 6200 @ 2696'
Press Corrected

Initial Hydrostatic	A	717
Final Hydrostatic	K	759
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

PRD Make _____
No. _____ Cap. _____ @ _____
Press Corrected

Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 5

Recorder No. 12985

0 min.	41 psig.	555 min.	146 psig.
15 "	132 "	570 "	146 "
30 "	134 "	585 "	146 "
45 "	135 "	600 "	146 "
60 "	136 "	615 "	146 "
75 "	137 "	630 "	147 "
90 "	138 "	645 "	147 "
105 "	139 "	660 "	147 "
120 "	139 "	675 "	148 "
135 "	140 "	690 "	148 "
150 "	140 "	705 "	148 "
165 "	141 "	720 "	148 "
180 "	141 "	735 "	149 "
195 "	141 "	750 "	149 "
210 "	142 "	765 "	149 "
225 "	142 "	780 "	149 "
240 "	142 "	795 "	149 "
255 "	142 "	810 "	149 "
270 "	142 "	825 "	149 "
285 "	143 "	840 "	149 "
300 "	143 "	855 "	149 "
315 "	143 "	870 "	149 "
330 "	143 "	885 "	150 "
345 "	143 "	900 "	150 "
360 "	144 "	915 "	150 "
375 "	144 "	930 "	151 "
390 "	144 "	945 "	151 "
405 "	144 "	960 "	152 "
420 "	144 "	975 "	152 "
435 "	144 "	990 "	152 "
450 "	144 "	1005 "	152 "
465 "	145 "	1020 "	152 "
480 "	145 "	1035 "	152 "
495 "	145 "	1050 "	152 "
510 "	145 "	1065 "	152 "
525 "	145 "	1075 "	152 "
540 "	145 "		

TEST 1-6

Phone
522-1206 Area 303

LYNES, INC.

Box 712
Sterling, Colo.

Spot	--	Csg. Size & Grade	13 3/8"
Sec.	--	Tubing Size	2 7/8" 6.5#
Twp.	--	Tool Depth	2740-2770'
Rng.	--	On Location @	--
Field	Rattle Snake Hill	Off Location @	--
County	Benton	Lynes Rep.	Stan Anama
State	Washington	Well Owners Rep.	Paul Eddy

Tool Description Treating & Testing Tool

Packer size 7 3/8" X 66"

PO# WTC-SBB-39166

Summary: Test #6

5-5-77

3:30 PM. Start in hole with tools.

7:30 PM. Tools in place. Let set overnight.

5-6-77

8:00 AM. Filled tubing and inflated packers with 500 psig. surface pressure.

9:30 AM. Moved tool to between position. Applied 600 psig. surface pressure with argon cylinders, bled pressure to 450 psig. Re-applied 600 psig., bled pressure to 500 psig. Held 500 psig. over weekend.

5-9-77

8:00 AM. Pressure @ 315 psig. Bled off pressure and released packers.

Flowing pressures in 15 minute increments on following pages.

Operator Arco Hanford Co.
Attn: Paul Eddy, Box 250
Address Richland, Washington 99352

Well Name and No. RSH #1
Type Tool Treating & Testing Tool

Date 5-5-77
Ticket No. 1156

LYNES, INC.

Operator Arco Hanford Co.Lease & No. RSH #1DST No. 6

Above Interval Kuster K-3		
PRD Make		
No. <u>12985</u>	Cap. <u>6100</u>	@ <u>2723'</u>
Press		Corrected
Initial Hydrostatic	A	714
Final Hydrostatic	K	714
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

Between Interval Kuster K-3		
PRD Make		
No. <u>15579</u>	Cap. <u>6200</u>	@ <u>2752'</u>
Press		Corrected
Initial Hydrostatic	A	743
Final Hydrostatic	K	--
Initial Flow	B	1733
Final Initial Flow	C	1251
Initial Shut-in	D	--
Second Initial Flow	E	1751
Second Final Flow	F	1610
Second Shut-in	G	--
Third Initial Flow	H	1660
Third Final Flow	I	1427
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 6

Clock # 16239 Set 4 Test 6
Recorder # N15214
48hr

(A)

Below Interval

PRD Make Kuster K-3
No. 15714 Cap. 6000 @ 2777'

Press		Corrected
Initial Hydrostatic	A	758
Final Hydrostatic	K	--
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

PRD Make _____
No. _____ Cap. _____ @ _____

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 6

Recorder No. 15579

Initial Flow

0 min.	1733	psig.
15 "	1387	"
30 "	1353	"
45 "	1335	"
60 "	1325	"
75 "	1312	"
90 "	1306	"
105 "	1301	"
120 "	1296	"
135 "	1293	"
150 "	1283	"
165 "	1277	"
180 "	1270	"
195 "	1264	"
210 "	1257	"
225 "	1251	"

Second Flow

0 min.	1751	psig.
15 "	1673	"
30 "	1641	"
45 "	1620	"
55 "	1610	"

LYNES, INC.

Operator Arco Hanford Co.Lease & No. RSH #1DST No. 6Recorder No. 15579

Final Flow

0 min.	1660 psig.	750 min.	1480 psig.	1500 min.	1450 psig.	2250 min.	1427 psig.
15 "	1641 "	765 "	1480 "	1515 "	1450 "	2265 "	1427 "
30 "	1618 "	780 "	1480 "	1530 "	1450 "	2270 "	1427 "
45 "	1607 "	795 "	1479 "	1545 "	1450 "		
60 "	1597 "	810 "	1479 "	1560 "	1450 "		
75 "	1592 "	825 "	1478 "	1575 "	1450 "		
90 "	1584 "	840 "	1478 "	1590 "	1449 "		
105 "	1576 "	855 "	1478 "	1605 "	1449 "		
120 "	1571 "	870 "	1477 "	1620 "	1448 "		
135 "	1568 "	885 "	1477 "	1635 "	1448 "		
150 "	1563 "	900 "	1476 "	1650 "	1447 "		
165 "	1556 "	915 "	1476 "	1665 "	1447 "		
180 "	1555 "	930 "	1476 "	1680 "	1446 "		
195 "	1552 "	945 "	1475 "	1695 "	1446 "		
210 "	1550 "	960 "	1475 "	1710 "	1445 "		
225 "	1545 "	975 "	1475 "	1725 "	1445 "		
240 "	1542 "	990 "	1474 "	1740 "	1444 "		
255 "	1539 "	1005 "	1474 "	1755 "	1443 "		
270 "	1537 "	1020 "	1474 "	1770 "	1442 "		
285 "	1534 "	1035 "	1473 "	1785 "	1442 "		
300 "	1529 "	1050 "	1473 "	1800 "	1441 "		
315 "	1526 "	1065 "	1472 "	1815 "	1440 "		
330 "	1526 "	1080 "	1472 "	1830 "	1439 "		
345 "	1526 "	1095 "	1472 "	1845 "	1438 "		
360 "	1526 "	1110 "	1471 "	1860 "	1437 "		
375 "	1525 "	1125 "	1471 "	1875 "	1436 "		
390 "	1525 "	1140 "	1471 "	1890 "	1436 "		
405 "	1525 "	1155 "	1470 "	1905 "	1435 "		
420 "	1525 "	1170 "	1469 "	1920 "	1435 "		
435 "	1524 "	1185 "	1467 "	1935 "	1434 "		
450 "	1524 "	1200 "	1466 "	1950 "	1433 "		
465 "	1523 "	1215 "	1465 "	1965 "	1433 "		
480 "	1519 "	1230 "	1463 "	1980 "	1432 "		
495 "	1518 "	1245 "	1462 "	1995 "	1432 "		
510 "	1517 "	1260 "	1460 "	2010 "	1431 "		
525 "	1514 "	1275 "	1458 "	2025 "	1430 "		
540 "	1511 "	1290 "	1457 "	2040 "	1429 "		
555 "	1508 "	1305 "	1456 "	2055 "	1429 "		
570 "	1505 "	1320 "	1455 "	2070 "	1429 "		
585 "	1502 "	1335 "	1454 "	2085 "	1428 "		
600 "	1499 "	1350 "	1453 "	2100 "	1428 "		
615 "	1496 "	1365 "	1450 "	2115 "	1428 "		
630 "	1493 "	1380 "	1450 "	2130 "	1428 "		
645 "	1491 "	1395 "	1450 "	2145 "	1428 "		
660 "	1489 "	1410 "	1450 "	2160 "	1427 "		
675 "	1486 "	1425 "	1450 "	2175 "	1427 "		
690 "	1484 "	1440 "	1450 "	2190 "	1427 "		
705 "	1483 "	1455 "	1450 "	2205 "	1427 "		
720 "	1482 "	1470 "	1450 "	2220 "	1427 "		
735 "	1481 "	1485 "	1450 "	2235 "	1427 "		

TEST 1-6

Water Pressures Between Packers*

<u>Time (Min)</u>	<u>PSIG</u>
0	1859
15	1609
60	1570
95	1541
260	1504
515	1466
2190	1440

*Electric tape measurement.

TEST 1-7

Phone
522-1206 Area 303

LYNES, INC.

Box 712
Sterling, Colo.

Spot	--	Csg. Size & Grade	13 3/8"
Sec.	--	Tubing Size	2 7/8" 6.5#
Twp.	--	Tool Depth	1650-1780'
Rng.	--	On Location @	--
Field	Rattle Snake Hill	Off Location @	--
County	Benton	Lynes Rep.	Stan Anama
State	Washington	Well Owners Rep.	Paul Eddy

Tool Description Treating & Testing Tool

Packer size 7 3/8" X 66"

PO# WTC-SBB-39166

Summary: Test #7

5-10-77
1:15 PM.

Packers in place, filled tubing and inflated packers with 500 psig surface pressure.

2:05 PM.

Moved tool to between position and began swabbing.

3:30 PM. Swabbed down. Left open for 980 minutes.

5-11-77
7:30 AM.

Ran swab for recovery. Recovered 30 gallons per swab, approximately 360 gallons per hour.

Flowing pressures in 15 minute increments on following pages.

Operator Arco Hanford Co.
Attn: Paul Eddy, Box 250
Address Richland, Washington 99352

Well Name and No. RSH #1
Type Tool Treating & Testing Tool

Date 5-10-77
Ticket No. 1156

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 7

Clock # 16218 Set 5 Test 7:8
Recorder # N12985
42 hr
Top

Above Interval		
PRD Make	Kuster K-3	
No. 12985	Cap. 6100	@ 1633'
Press		Corrected
Initial Hydrostatic	A	251
Final Hydrostatic	K	251
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

Clock # 16239 Set 5 Test 7:8
Recorder # 15719
Between

Between Interval		
PRD Make	Kuster K-3	
No. 15714	Cap. 6000	@ 1662'
Press		Corrected
Initial Hydrostatic	A	268
Final Hydrostatic	K	283
Initial Flow	B	114
Final Initial Flow	C	268
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Arco Hanford Co.Lease & No. RSH-#1UST No. 7

Clock # 12306 Set 5
 Recorder # 15579 Test 7 & 8
 Bottom 60 1/2"

(A)

(K)

Below Interval

Kuster K-3

PRD Make

No. 15579

Cap. 6200

@ 1786'

Press

Corrected

Initial Hydrostatic A 322

Final Hydrostatic K 285

Initial Flow B --

Final Initial Flow C --

Initial Shut-in D --

Second Initial Flow E --

Second Final Flow F --

Second Shut-in G --

Third Initial Flow H --

Third Final Flow I --

Third Shut-in J --

Pressure Below Bottom
Packer Bled To

PRD Make

No.

Cap.

@

Press

Corrected

Initial Hydrostatic A

Final Hydrostatic K

Initial Flow B

Final Initial Flow C

Initial Shut-in D

Second Initial Flow E

Second Final Flow F

Second Shut-in G

Third Initial Flow H

Third Final Flow I

Third Shut-in J

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 7

Recorder No. 15714

0 min.	114 psig.	510 min.	250 psig.
15 "	184 "	525 "	250 "
30 "	199 "	540 "	253 "
45 "	212 "	555 "	253 "
60 "	222 "	570 "	253 "
75 "	227 "	585 "	255 "
90 "	232 "	600 "	258 "
105 "	232 "	615 "	259 "
120 "	237 "	630 "	260 "
135 "	240 "	645 "	261 "
150 "	242 "	660 "	263 "
165 "	242 "	675 "	263 "
180 "	247 "	690 "	263 "
195 "	210 "	705 "	263 "
210 "	253 "	720 "	264 "
225 "	258 "	735 "	265 "
240 "	263 "	750 "	268 "
255 "	263 "	765 "	268 "
270 "	263 "	780 "	268 "
285 "	264 "	795 "	268 "
300 "	265 "	810 "	268 "
315 "	265 "	825 "	263 "
330 "	265 "	840 "	260 "
345 "	263 "	855 "	255 "
360 "	260 "	870 "	253 "
375 "	258 "	885 "	253 "
390 "	253 "	900 "	253 "
405 "	247 "	915 "	253 "
420 "	247 "	930 "	253 "
435 "	245 "	945 "	253 "
450 "	245 "	960 "	256 "
465 "	247 "	975 "	263 "
480 "	247 "	980 "	268 "
495 "	250 "		

TEST 1-8

Phone
522-1206 Area 303

LYNES, INC.

Box 712
Sterling, Colo.

Spot	--	Csg. Size & Grade	13 3/8"
Sec.	--	Tubing Size	2 7/8" 6.5#
Twp.	--	Tool Depth	1780-2860'
Rng.	--	On Location @	--
Field	Rattle Snake Hill	Off Location @	--
County	Benton	Lynes Rep.	Stan Anama
State	Washington	Well Owners Rep.	Paul Eddy

Tool Description Treating & Testing Tool

Packer size 7 3/8" X 66"

P0# WTC-SBB-39166

Summary: Test # 8

5-11-77

8:50 AM. Filled tubing and moved tool to below position. Began swabbing.

9:19 AM. Swabbed down. Left open for 116 minutes.

11:15 AM. Ran swab to check recovery. 1st run recovered 50 gallons, 2nd run recovered 55 gallons.

11:27 AM. Equalized and released packers.

Flowing pressures in 15 minute increments on following pages.

Operator Arco Hanford Co.
Attn: Paul Eddy, Box 250
Address Richland, Washington 99352

Well Name and No. RSH #1
Type Tool Treating & Testing Tool

Date 5-11-77
Ticket No. 1156

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 8

Clock # 16218 Set 5 Test 7 & 8
Recorder # N12985
48 hr
Top

Above Interval

PRD Make Kuster K-3
No. 12985 Cap. 6100 @ 1763'

Press		Corrected
Initial Hydrostatic	A	251
Final Hydrostatic	K	251
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

Clock # 16239 Set 5 Test 7 & 8
Recorder # 15719
Between

Between Interval

PRD Make Kuster K-3
No. 15714 Cap. 6000 @ 1792'

Press		Corrected
Initial Hydrostatic	A	268
Final Hydrostatic	K	283
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 8

Clock # 12306 Set 5
Recorder # 15579 Test 7 of 8
Bottom 60 in.

A

B

C

K

Below Interval

Kuster K-3

PRD Make Kuster K-3
No. 15579 Cap. 6200 @ 2866'

Press		Corrected
Initial Hydrostatic	A	322
Final Hydrostatic	K	285
Initial Flow	B	141
Final Initial Flow	C	288
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

PRD Make _____
No. _____ Cap. _____ @ _____

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Arco Hanford Co. Lease & No. RSH #1 DST No. 8

Recorder No. 15579

0 min.	141 psig.
15 "	262 "
30 "	275 "
45 "	277 "
60 "	280 "
75 "	283 "
90 "	284 "
105 "	106 "
116 "	288 "

TEST 2-1

Phone
522-1206 Area 303

LYNES, INC.

Box 712
Sterling, Colo.

Spot	--	Csg. Size & Grade	13 3/8"
Sec.	--	Tubing Size	--
Twp.	--	Tool Depth	2780-2820'
Rng.	--	On Location @	--
Field	--	Off Location @	--
County	Benton	Lynes Rep.	Stan Anama
State	Washington	Well Owners Rep.	Paul Eddy

Tool Description 5"-Treating & Testing Tool

Test #1

Summary:

9-30-77

- 7:30 PM. Set tool in place.
- 7:31 PM. Began filling tubing.
- 9:00 PM. Tubing full. Inflated packers with 437 psig. static and 800 psig surface pressure.
- 9:30 PM. Moved to between position.
- 9:54 PM. Began monitoring fluid level with iron horse.

10-1-77

Monitered water level in tubing for 24 hours.

10-2-77

- 9:37 AM. Monitered water level in tubing.
- 9:47 AM. Filled tubing to surface.
- 10:00 AM. Moved to equalize.
- 10:15 AM. Deflated packers and tripped out of hole.
- 4:00 PM. Tools out of hole. Ran iron horse in to get static fluid level, found level at 1012.5'.

Operator
Address
Rockwell Hanford Operations
Box 800
Richland, Washington 99352

Well Name and No.
Type Tool
RSH #1
Treating & Testing Tool

Date
Ticket No.
9-30-77
8581

LYNES, INC.

Operator Rockwell Hanford Operations Lease & No. RSH #1 DST No. --

9/30/77 - 10/2/77
Recorder No. 14328
Clock No. 18428 (48 hr)
Above top packer

Above		
PRD Make	Kuster K-3	
No.	14328	Cap. 2900 @ 2765'
Press	Corrected	
Initial Hydrostatic	A	658
Final Hydrostatic	K	--
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

9/30/77 - 10/2/77
Recorder No. N4325
Clock No. 18425 (48 hr)
Between packers

Between		
PRD Make	Kuster K-3	
No.	14325	Cap. 2900 @ 2791'
Press	Corrected	
Initial Hydrostatic	A	674
Final Hydrostatic	K	--
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

Clock ran out 2177 minutes
into test.

LYNES, INC.

Operator Hydrologic Testing Operations Lease & No. RSH #1 DST No. --

9/30/77 - 10/2/77
 Recorder No. 13003
 Clock No. 18427 (48 hr)
 Below Packers

Below

PRD Make Kuster K-3
 No. 13003 Cap. 2900 @ 2830'

Press		Corrected
Initial Hydrostatic	A	--
Final Hydrostatic	K	--
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
 Packer Bled To

PRD Make _____
 No. _____ Cap. _____ @ _____

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	

Pressure Below Bottom
 Packer Bled To

LYNES, INC.

Operator Rockwell Hanford Operations Lease & No. RSH #1 DST No. --

Recorder No. 14325

0 min.	1218 psig.
30 "	1199 "
60 "	1187 "
90 "	1181 "
120 "	1176 "
150 "	1171 "
180 "	1167 "
210 "	1165 "
240 "	1163 "
270 "	1161 "
300 "	1161 "
360 "	1156 "
420 "	1153 "
480 "	1147 "
540 "	1144 "
600 "	1141 "
660 "	1139 "
720 "	1137 "
780 "	1136 "
840 "	1134 "
900 "	1132 "
960 "	1128 "
1020 "	1126 "
1080 "	1123 "
1140 "	1122 "
1200 "	1121 "
1260 "	1120 "
1320 "	1119 "
1380 "	1116 "
1440 "	1114 "
1500 "	1111 "
1560 "	1110 "
1620 "	1109 "
1680 "	1108 "
1740 "	1107 "
1800 "	1106 "
1860 "	1105 "
1920 "	1104 "
1980 "	1102 "
2040 "	1100 "
2100 "	1100 "
2160 "	1099 "
2177 "	1099 "

TEST 2-1

Water Pressures Between Packers*

<u>Time (Min)</u>	<u>PSIG</u>
0	1218
30	1209
45	1203
60	1199
90	1192
120	1187
150	1183
180	1179
240	1174
300	1170
600	1152
900	1140
1080	1134
1110	1133
1350	1127
1590	1120
1830	1114
2070	1112
2160	1108

*Electric tape measurement.

TEST 2-2

Phone
522-1206 Area 303

LYNES, INC.

Box 712
Sterling, Colo.

Spot	--	Csg. Size & Grade	13 3/8"
Sec.	--	Tubing Size	--
Twp.	--	Tool Depth	2717-2739'
Rng.	--	On Location @	7:30 AM. 10-3-77
Field	--	Off Location @	9:00 AM. 10-5-77
County	Benton	Lynes Rep.	Stan Anama
State	Washington	Well Owners Rep.	Paul Eddy

Tool Description 5" Treating & Testing Tool

Test #2

Summary:

10-3-77

12:00 Set tool in place.

12:04 PM. Began filling tubing.

1:05 PM. Tubing full. Inflated packers with 433 psig. static and 600 psig. surface pressure.

1:32 PM. Moved to between position. Applied 570 psig. Pressure bled to zero. Rigged gauge and tubing head and applied 1000 psig. Monitered gauge pressure.

10-4-77

8:40 AM. Monitered surface pressure at gauge, pressure to zero.

Monitered fluid level for 24 hours.

10-5-77

8:40 AM. Moved to equalize for 5 minutes.

8:47 AM. Deflated packers and tripped out of hole.

3:30 PM. Tools out of hole. Found fluid level at 1010.5'.

Operator
Rockwell Hanford Operations
Box 800
Richland, Washington 99352

Well Name and No. RSH #1

Type Tool
Treating & Testing Tool

Date
10-3-77

Ticket No.
8581

LYNES, INC.

Operator Rockwell Hanford Operations Lease & No. RSH #1 DST No. --

ABOVE
SET 2
N 14326 RECORDER
18428 CLOCK
TEST #2

Above
PRD Make Kuster K-3
No. 14326 Cap. 2900 @ 2702'

Press		Corrected
Initial Hydrostatic	A	744
Final Hydrostatic	K	--
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

BETWEEN
SET 2
N 14325 RECORDER
18425 CLOCK
TEST #2

Between
PRD Make Kuster K-3
No. 14325 Cap. 2900 @ 2728'

Press		Corrected
Initial Hydrostatic	A	--
Final Hydrostatic	K	--
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Rockwell Hanford Operations Lease & No. RSH #1 DST No. --

BOTTOM
CHART
SET 2 705T #2 48.42

13003 RECORDER
18427 CLOCK

Below

PRD Make Kuster K-3
No. 13003 Cap. 2900 @ 2749'

Press Corrected

Initial Hydrostatic	A	768
Final Hydrostatic	K	--
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

PRD Make _____
No. _____ Cap. _____ @ _____

Press Corrected

Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Rockwell Hanford Operations Lease & No. RSH #1 DST No. --

Recorder No. 14325

0 min.	2197 psig.	870 min.	1248 psig.
30 "	1901 "	900 "	1241 "
60 "	1789 "	960 "	1227 "
90 "	1710 "	1020 "	1216 "
120 "	1652 "	1080 "	1205 "
150 "	1604 "	1140 "	1199 "
180 "	1566 "	1200 "	1199 "
210 "	1536 "	1260 "	1199 "
240 "	1509 "	1320 "	1199 "
270 "	1484 "	1380 "	1199 "
300 "	1463 "	1440 "	1199 "
330 "	1445 "	1500 "	1199 "
360 "	1428 "	1560 "	1199 "
390 "	1411 "	1620 "	1199 "
420 "	1395 "	1680 "	1199 "
450 "	1390 "	1740 "	1199 "
480 "	1366 "	1800 "	1199 "
510 "	1353 "	1860 "	1199 "
540 "	1341 "	1920 "	1199 "
570 "	1330 "	1980 "	1199 "
600 "	1320 "	2040 "	1199 "
630 "	1312 "	2100 "	1199 "
660 "	1303 "	2160 "	1199 "
690 "	1297 "	2220 "	1199 "
720 "	1287 "	2280 "	1199 "
750 "	1276 "	2340 "	1200 "
780 "	1269 "	2400 "	1202 "
810 "	1263 "	2460 "	1204 "
840 "	1256 "	2464 "	1204 "

TEST 2-2

Water Pressures Between Packers*

<u>Time (Min)</u>	<u>PSIG</u>
0	2186
15	2116
30	1976
60	1834
120	1683
180	1586
240	1518
370	1426
550	1346
790	1266
1090	1206
1135	1186
1330	1186
1510	1185
2350	1184
2405	1184
2435	1184

*Electric tape measurement.

TEST 2-3

Phone
522-1206 Area 303

LYNES, INC.

Box 712
Sterling, Colo.

Spot	--	Csg. Size & Grade	13 3/4"
Sec.	--	Tubing Size	--
Twp.	--	Tool Depth	2622-2676'
Rng.	--	On Location @	--
Field	--	Off Location @	--
County	Benton	Lynes Rep.	Stan Anama
State	Washongton	Well Owners Rep.	Paul Eddy

Tool Description 5" Treating & Testing Tool

Test. #3

Summary:

10-6-77

8:00 AM. Set tool in place.

12:00 Began filling tubing.

12:30 PM. Tubing full.

1:30 PM. Inflated packers with 433 psig static and 650 psig surface pressure.

1:40

1:40 PM. Moved tool to between position.

1:42 PM. Monitered gauge pressure. Surface pressure dropped to zero.

10-7-77

Monitered fluid for 24 hours.

10-8-77

8:30 AM. Took last reading. Ran iron horse in annulus, found static fluid level at 1010'.

9:08 AM. Ran iron horse in annulus and found static fluid level at 1010'.

9:12 AM. Moved to equalize position.

1:00 PM. Deflated packers and tripped out of hole.

Operator
Address
Rockwell Hanford Operations
Box 800
Richland, Washington 99352

Well Name and No. RSH #1
Type Tool
Treating & Testing Tool

Date
Ticket No.
10-6-77
8581

LYNES, INC.

Operator Rockwell Hanford Operations Lease & No. RSH #1 DST No. --

Above		
PRD Make	Kuster K-3	
No. 14326	Cap. 2900	@ 2607'
Press	Corrected	
Initial Hydrostatic	A	694
Final Hydrostatic	K	--
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

Between		
PRD Make	Kuster K-3	
No. 14325	Cap. 2900	@ 2633'
Press	Corrected	
Initial Hydrostatic	A	--
Final Hydrostatic	K	--
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

Clock ran out 2475 minutes
into test.

LYNES, INC.

Operator Rockwell Hanford Operations Lease & No. RSH #1 DST No. --

Below		
PRD Make <u>Kuster K-3</u>		
No. <u>13003</u> Cap. <u>2900</u> @ <u>2686'</u>		
Press		Corrected
Initial Hydrostatic	A	722
Final Hydrostatic	K	--
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--

Pressure Below Bottom
Packer Bled To

PRD Make _____		
No. _____ Cap. _____ @ _____		
Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	

Pressure Below Bottom
Packer Bled To

LYNES, INC.

Operator Rockwell Hanford Operations Lease & No. RSH #1 DST No. --

Recorder No. 14325

0 min.	1160 psig.	1020 min.	921 psig.
30 "	1122 "	1080 "	916 "
60 "	1092 "	1140 "	912 "
90 "	1171 "	1200 "	910 "
120 "	1054 "	1260 "	906 "
150 "	1039 "	1320 "	904 "
180 "	1028 "	1380 "	900 "
210 "	1018 "	1440 "	896 "
240 "	1012 "	1500 "	894 "
270 "	1005 "	1560 "	890 "
300 "	1000 "	1620 "	887 "
330 "	993 "	1680 "	885 "
360 "	989 "	1740 "	883 "
390 "	984 "	1800 "	883 "
420 "	979 "	1860 "	881 "
450 "	976 "	1920 "	877 "
480 "	971 "	1980 "	874 "
510 "	967 "	2040 "	872 "
540 "	963 "	2100 "	870 "
570 "	959 "	2160 "	870 "
600 "	955 "	2220 "	869 "
660 "	949 "	2280 "	867 "
720 "	944 "	2340 "	865 "
780 "	939 "	2400 "	861 "
840 "	934 "	2460 "	860 "
900 "	930 "	2475 "	860 "
960 "	927 "		

TEST 2-3

Water Pressures Between Packers*

<u>Time (Min)</u>	<u>PSIG</u>
0	1159
10	1158
30	1154
50	1128
65	1089
125	1080
175	1053
220	1035
400	1023
580	992
820	970
1120	948
1300	927
1480	917
1540	908
2440	873
2500	872
2530	871

*Electric tape measurement.